[^{131}I] Hippuran Renography in the Detection of Orthostatic Hypertension

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Scintigrams in prone and standing positions were done in 11 hypertensive women. All had nephroptosis with ventral rotation. On the basis of the renograms, seven patients were identified as suffering from orthostatic hypertension. Nephropexy resulted in normalization of blood pressure in six of the seven patients and normalization of the renograms of all seven. We believe that sequence scintigrams in prone and standing positions offer a simple method of identifying patients with orthostatic hypertension.

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The detection of orthostatic hypertension seems especially important since nephropexy offers an effective remedy. Recent studies indicate that orthostatic hypertension may have greater clinical significance than has been recognized (*1,2*). The present study sought to evaluate the usefulness of the radionuclide renogram as a screening test for orthostatic hypertension.

METHOD

Eleven patients with nephroptosis and hypertension are included in the present study. All were female. They ranged in age from 22 to 48 yr, average 32. All had nephroptosis with torsion. An i.v. pyelogram (IVP) was done in ten of the eleven patients, one being sensitive to iodinated radiographic contrast media. In eight of the ten patients the last radiograph of the IVP was taken in the upright position. Together with the IVP, static scintiphotos in prone and standing positions were used to document the type and extent of renal movement. Static scintiphotos followed the injection of 1.5 mCi Tc-99m-Fe Complex*. The scintigrams in the prone and standing positions were made after the injection of 4 μCi [^{131}I] Hippurate per kilogram body weight. A 12-in. gamma camera was used for most of the preoperative studies. It was replaced in the fall of 1976 with a 15-in. gamma camera, so that many of the postoperative studies were performed with this camera. Data were stored on magnetic tape and were analyzed by minicomputer. For practical reasons the general-purpose medium-energy parallel-hole collimator was used for both the hippurate and the Tc-Fe complex. A window setting at 25%, centered over the photopeak of the tracer, was used in both studies.

Regions of interest (ROI) were placed over the left and right kidneys to determine single-kidney hippurate uptake. No attempt was made to exclude the renal pelvic system. The considerable movement of the kidneys made it necessary to reselect ROI for each examination. Background subtraction was performed, its ROI being placed under the left kidney. The area of the background ROI was kept small—generally one fourth of that of the kidney ROI—and was then prorated to correspond to the areas used for the kidneys. The single-kidney hippurate uptake, expressed as a percentage of the sum of both, was determined. Uptake was taken as proportional to a quasitriangular area bounded by (a) the renogram between 36 and 120 sec, (b) a vertical line dropped

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TABLE 1. COMPARISON OF BLOOD PRESSURE (BP) AND HIPPURATE UPTAKE BY RIGHT KIDNEY (AS PERCENTAGE OF BILATERAL UPTAKE)) IN PRONE AND STANDING POSITIONS BEFORE AND AFTER NEPHROPEXY

	Preoperative			Postoperative		
Case No.	BP	Prone %	Standing %	BP	Prone %	Standing %
1	Intermit. hyper.	49	39	160/110	49	50
2	140/100	43	31	130/80	50	50
3	220/120	42	32	130/90	45	47
4	180/100	58	40	120/80	48	50
5	150/115	52	43	130/80	50	53
6	180/100	45	30	130/80	50	50
7	120/80 Under antihypertensive therapy	45	30	130/80	45	47
	Patients considered not to have orthostatic hypertension					
8	160/120	50	50	140/90	47	53
9	170/120	49	46	150/100	47	50
10	160/100	44	42	150/110	40	43
11	150/100	49	50	150/100	Not reexamined scintigraphically	

from the 120-sec level, and (c) a horizontal line through the 36-sec level.

Nephropexy was performed in all patients of this series, regardless of the results of the emission renogram. Six to 18 months after nephropexy the patients were re-examined. Static scintiphotos were again made to determine whether stabilization of the floating kidney had been achieved. The sequence scintigram was repeated in the prone and standing positions and was compared with the preoperative images. The postoperative examination also included blood-pressure control and a short case report covering the time since nephropexy. One patient was not scintiphotographed postoperatively. She was retained in the study because her hypertension was classified preoperatively as nonorthostatic. We considered the diagnosis verified when her hypertension persisted after the operation.

RESULTS

Seven patients were identified on the basis of the emission renograms as having orthostatic hypertension. These patients had all shown considerable second-phase renogram flattening when examined in the standing position. Compared with the examination in the prone position, they showed reduced hippurate uptake in upright posture. Six of these hypertensive patients gave normal blood-pressure values after nephropexy (Table 1). The recovery of normal blood pressure after nephropexy was accompanied by normalization of the renograms (Fig. 1 and Table 2). The one patient whose blood pressure failed to

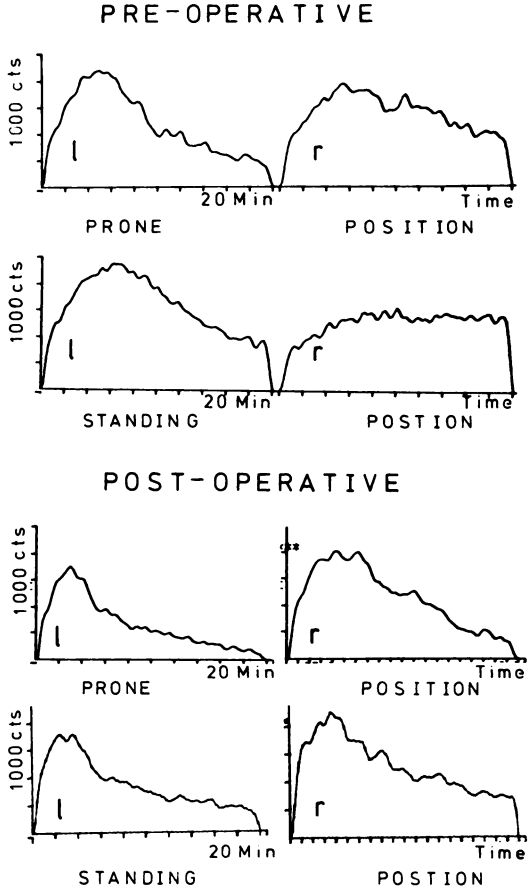

FIG. 1. Emission renograms from a 40-year-old woman (No. 6) with nephroptosis with torsion, referred to us with back pain in the prone position, hypertension (180/100), and recurring urinary-tract infections. Nephropexy was performed because of hypertension and a posture-dependent second-phase renogram change. Result was normalization of blood pressure (130/80) and renograms. During first 6 mo after nephropexy no urinary-tract infection was observed.

TABLE 2

Deflection value				Peak time (min)				Peak value (mm)				Height (10 min)				Height (20 min)			
Prone		Standing		Prone		Standing		Prone		Standing		Prone		Standing		Prone		Standing	
Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Mean renogram values of patients considered to have orthostatic hypertension. Data obtained in prone and standing positions before nephropexy.																			
2.27	2.46	1.54	2.37	5.2	4.1	7.5	4.7	44	45	33	47	31	22	26	26	17	10	19	14
Mean renogram values of patients considered not to have orthostatic hypertension. Data obtained in prone and standing positions before nephropexy.																			
2.1	2.0	2.8	3.1	6.1	4.3	3.7	3.0	44	42	45	35	32	22	23	22	15	12	15	14
Mean renogram values of patients considered to have orthostatic hypertension. Data obtained in prone and standing positions after nephropexy.																			
2.6	2.4	2.2	2.0	4.2	3.4	7.6	5.7	43	46	44	36	24	20	28	21	11	6	17	7
Mean renogram values of patients considered not to have orthostatic hypertension. Data obtained in prone and standing positions after nephropexy.																			
2.4	2.5	3.0	2.9	4.7	3.3	3.6	3.0	46	42	40	21	27	18	18	18	13	9	10	7

respond to nephropexy did demonstrate a normalization of the renogram curves.

Four hypertensive patients with ptosis and rotation failed to show posture-dependent renogram changes typical of orthostatic hypertension. Three of these patients continued to be hypertensive after nephropexy and the operation did not improve the abnormal renograms. One patient, however, reacted to nephropexy with complete normalization of blood-pressure values. Her renograms were normal both before and after nephropexy. Prior to the operation she had elevated renin levels, which normalized during forced, preoperative bed rest. Angiography failed to demonstrate stenosis, but showed that the right renal artery was elongated.

The mean downward movement of the ptotic kidney in patients with orthostatic hypertension was 6.6 cm. The control group of patients demonstrating ptosis and hypertension exhibited a mean downward motion of 9 cm (Table 3). We noted that patients with relatively small caudal motion and orthostatic hypertension showed considerable torsion. Thus the right kidney of patient No. 5 showed only 5.5 cm of downward movement but with extensive torsion. In the prone position the length of the right kidney, as measured by radiograph, was 13 cm, but was only 9 cm in upright position. We found that roentgenograms are effective in registering downward motion, whereas scintiphotos demonstrate torsion better (Fig. 2).

TABLE 3. EXTENT OF RENAL MOBILITY MEASURED BY COMPARING X-RAYS OBTAINED IN RECUMBENT AND UPRIGHT POSTURES DURING I.V. PYELOGRAPHY

Case No.	Renal movement (cm)
1	5
3	6
5	8
6	5.5
7	8.5
Patients considered not to have orthostatic hypertension	
8	8
9	9.5
10	9.5

DISCUSSION

McCann and Romansky (*3*) demonstrated that renal ptosis can be the cause of hypertension. In four hypertensive patients, nephropexy restored normal blood pressures. Kaufman (*4*) found an association between nephroptosis, hypertension, and fibromuscular hyperplasia. He advocated upright renal arteriography to help identify patients with orthostatic hypertension. Mathe and Sanchez (*5*) successfully treated two hypertensive patients with nephropexy. Bianchi (*6*) described a questionable case of orthostatic hypertension. Recently De Zeeuw (*1*) attempted to analyze statistically the relationship between nephroptosis and hypertension. He found a high correlation between female hypertension and excessive renal mobility. These findings urge reconsideration of Mathe's (*5*) suggestion that patients with orthostatic hypertension may be among those generally classified as having essential hypertension.

Ptosis-induced hypertension was correctly identified by McCann and Romansky (*3*) as a Goldblatt hypertension. This Goldblatt hypertension was considered orthostatic, since the authors demonstrated that prolonged, strict bed rest would restore normal

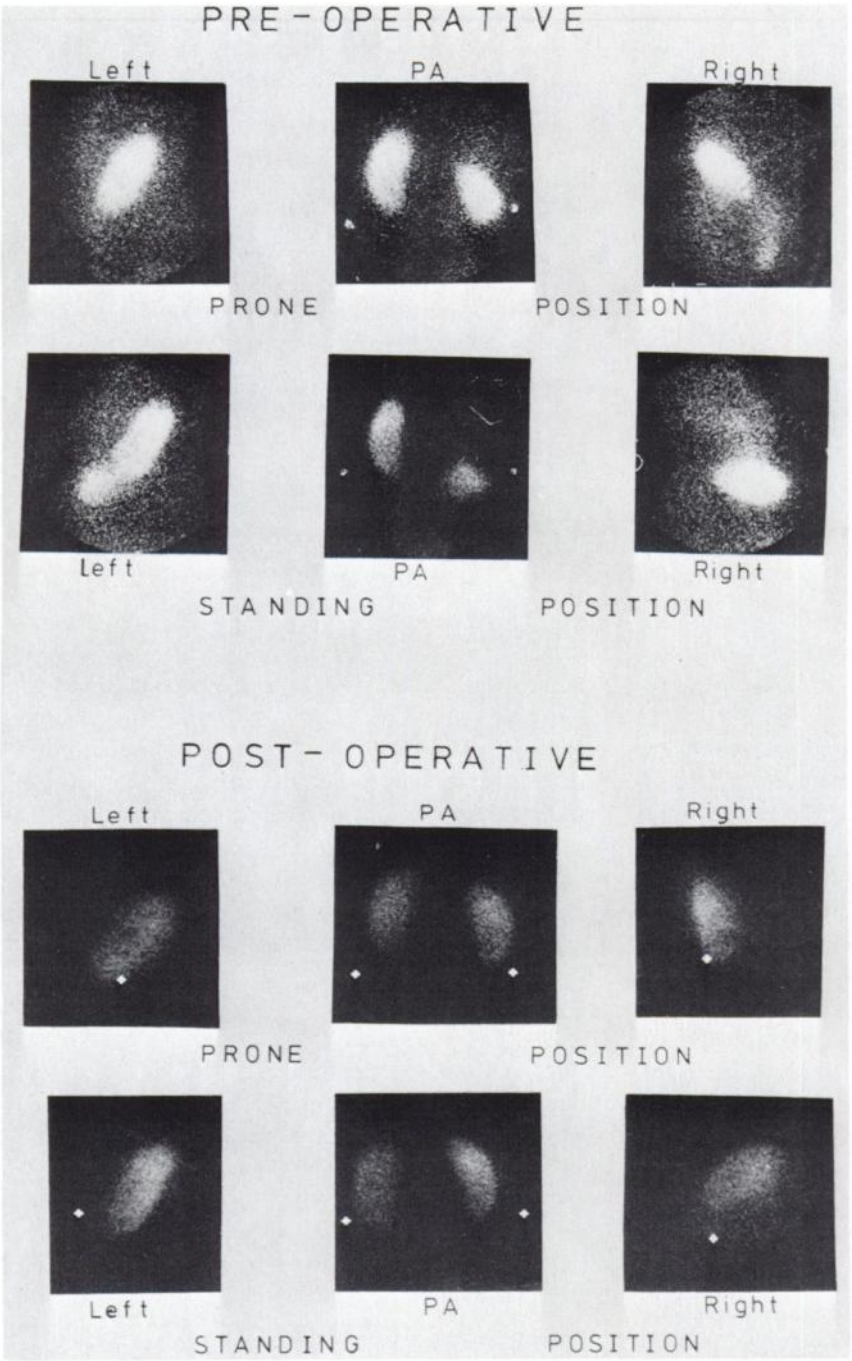

FIG. 2. Scintiphotos of kidneys (same patient) in posterior and right and left lateral views, in prone and standing positions, before and after nephropexy. Extensive torsion in upright position is seen at preoperative examination. Nephropexy resulted in stabilization of kidney.

blood pressure. It would be incorrect, however, to assume that these patients demonstrate hypertension while upright and be normotensive when prone. We did not find a difference between prone and upright blood-pressure values. McCann postulated that the erect position results in "some slight interference with the afferent blood supply." According to Poiseuille's law the flow of a viscous fluid through a tube is dependent upon the radius of the vessel, when all other things remain unchanged. Stretching the renal artery results in a reduction of the vascular lumen. A reduction of the vascular diameter by one fourth would result in a reduction of blood flow to one third of the original value. Kaufmann et al. (*4*) showed that fibromuscular hyperplasia of the renal artery was commonly associated with excessive renal mobility. The intermittent stretching was felt to have a causal influence on this condition. The reduction of the vascular lumen due to fibromuscular hyperplasia can, in conjunction with ptosis, result in functional renal-artery stenosis in the upright posture. Orthostatic hypertension, however, seems to occur primarily in

patients demonstrating torsion of the kidney (*1,2*). Torsion may result in irregularities of the vascular wall that greatly increase flow resistance, further reducing renal blood flow.

We believe that the radionuclide renogram, in spite of its shortcomings, can be used advantageously in screening patients for the presence of orthostatic hypertension. The prone examination is used as a reference for the renogram in upright posture. The posture-dependent reduction of hippurate uptake by the ptotic kidney is registered. Unilateral disturbances of renal function, not due to nephroptosis, show no major postural change in hippurate uptake. We considered orthostatic hypertension to exist when hypertensive patients with nephroptosis demonstrated a posture-dependent reduction of hippurate uptake in the ptotic kidney. Where nephropexy resulted in normalization of blood pressure, orthostatic hypertension was felt to have existed. Note that renal mobility, especially when associated with rotation, can increase the distance between the kidney and the camera. Increased tissue absorption can then cause a simple reduction in counting rate in the upright posture. We find that this source of error will not compromise a diagnosis if one disregards (as we do) uptake losses of 10% or less. Furthermore, a reduction in count rate from this source does not lead to a flattening of the second curve segment, which we regularly found in this patient population.

FOOTNOTE

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