

SIGNIFICANCE OF ^{18}F -FLUORIDE RENAL ACCUMULATION DURING BONE IMAGING

Shyam M. Sharma and James L. Quinn III

Northwestern University Medical School and Chicago Wesley Memorial Hospital, Chicago, Illinois

A number of workers have shown the superiority of ^{18}F -fluoride over other radionuclides which are conventionally used as bone scanning agents (1-4). The fact that ^{18}F -fluoride is becoming more readily available has also added to its increasing popularity. Although good-quality bone scans are possibly due to higher photon yield, high lesion-to-normal bone ratio and rapid clearance of ^{18}F from soft tissues and blood, its rapid renal excretion makes scan interpretation difficult in bone adjacent to kidneys and bladder. Blau, et al (4) recommended increased fluid intake after injection of ^{18}F -fluoride for enhancing its excretion and for reducing renal radioactivity.

This study was carried out with the dual purpose of determining the efficacy of fluid restriction 4 hr before injection of ^{18}F in reducing the renal and bladder activity at the time of the scan and for assessing the significance of the degree and pattern of ^{18}F renal accumulation with regard to kidney disease.

MATERIALS AND METHODS

The study includes 160 consecutive patients referred for bone scanning during 1971. Anterior and posterior scans of the lumbosacral and pelvic regions were examined in retrospect for accumulation of ^{18}F in the kidneys. Scans covering the kidney region were not available in 18 patients and were excluded from the study.

The remaining 142 patients were categorized according to the degree of ^{18}F renal concentration (nil, slight, fair, and marked) and also according to whether the concentration in the two kidneys was equal or unequal. Two patients in whom kidney and ureter were simultaneously visualized have been grouped separately. The scans were assigned to one of the above groups on the basis of visual inspection alone.

Hospital records of all the patients were examined for any pointers in clinical history and laboratory

studies indicative of renal function and morphology. Such information was only available in 27 of the 142 patients. Intravenous pyelograms (IVP) and ^{131}I -Hippuran renograms done within 2 weeks of the bone scan were available in 22 and 2 patients, respectively. The remaining three patients either had a clinically documented or autopsy-proven evidence of renal disease.

In all but seven patients, no comments about ^{18}F concentration in the kidney were made in the scan reports. Renal pathology was confirmed either by IVP or ^{131}I renograms in four patients, and in the remaining three patients no confirmatory studies were available.

Technique for ^{18}F bone scans. From 3 to 10 mCi of ^{18}F -fluoride (NaF) was administered intravenously around noon after the patients had been kept NPO after breakfast. The patients were instructed to void immediately before scanning was started, 4 hr after injection. This was done in an effort to reduce the accumulation of ^{18}F in the bladder at the time of the scan. Simultaneous anterior and posterior scans of the entire torso were obtained using a dual 5-in. detector scanner. The detector heads were fitted with 151-hole, 6-in. focus collimators having a resolution distance of 1.2 cm. The spectrometer settings were adjusted around the positron annihilation energy of 0.511 MeV of ^{18}F . The scans were run with an information density of 300-400 counts/cm². The patients were instructed to force fluids after the procedure.

RESULTS

Representative scans of the lumbar area illustrating slight, fair, and marked concentration of ^{18}F in

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For reprints contact: Shyam M. Sharma, Chicago Wesley Memorial Hospital, 250 E. Superior St., Chicago, Ill. 60611.

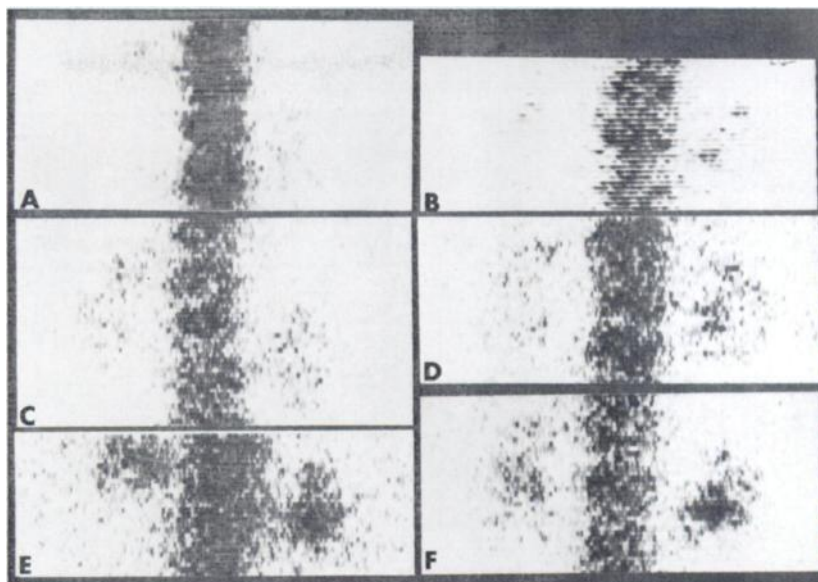


FIG. 1. Representative scans of lumbar area showing slight, fair, and marked concentration of ^{18}F in kidneys with equal (A,C,E) and unequal (B,D,F) concentration.

the kidneys with equal or unequal concentration are shown in Fig. 1.

Of the 142 patients studied, 55 (38.7%) had no ^{18}F concentration in the kidneys. The remaining 87 patients showed slight concentration in 39 patients (27.4%), fair in 35 patients (24.6%), marked in 11 patients (7.7%), and 2 patients showed simultaneous visualization of ureter and kidney.

Concentration of ^{18}F was unequal in 31 patients (21.7%) and equal in the remaining 111 patients (79.3%). Eight of the 31 patients had slight but unequal (SU) concentration (25.8%), 13 had fair and unequal (FU) concentration (41.9%), and 10 had marked and unequal (MU) concentration (32.3%) of ^{18}F in the kidneys.

The functional and morphological status of the kidneys as determined by clinical history, laboratory investigations (IVP, ^{131}I -Hippuran renogram), and autopsy findings was available in 27 patients. Five of the ten patients studied in the group with no ^{18}F in the kidneys (O) revealed renal abnormalities. None of the four patients with equal but slight (SE), fair (FE), or marked (ME) concentration had an abnormal study while 11 out of the 13 patients with unequal ^{18}F concentration in the kidneys (Groups SU, FU, MU, and M+U) showed renal pathology.

Table 1 correlates ^{18}F concentration in the kidneys as seen on the scans and results of other investigations in the 16 patients with abnormal studies. The abnormalities encountered in the five Group O patients include benign cyst, large peripelvic mass, and metastases in the kidneys. Abnormalities in 11 patients showing unequal concentration of ^{18}F in the kidneys (Groups SU, FU, MU, and M+U) included duplication of collecting system of one of the

kidneys, calculus in the kidney, hydronephrosis with hydroureter, dilatation of renal pelvis consequent to ureteric obstruction, and nonfunctioning kidney.

DISCUSSION

During the earlier period, patients referred for ^{18}F bone imaging were instructed to force fluids after injection of the radionuclide. Contrary to the experience of others, eight patients studied in this manner showed significant bladder activity while two patients who could not be hydrated showed little bladder activity. Subsequently, a followup study on 14 patients confirmed that dehydration of patients before injection significantly decreased the accumulation of radionuclide to minimal levels in 12 patients. The present series, comprised of 142 patients, also shows absent or slight ^{18}F renal activity in 94 patients (66.1%). Emptying the bladder immediately before scanning helped to reduce interfering activity. No data are available in the literature regarding the efficacy of postinjection hydration of the patients in reducing the ^{18}F concentration in the kidneys at the time of the scan.

Five out of the ten patients in Group O had renal pathology, indicating that absence of ^{18}F activity in the kidneys at the time of the scan does not preclude renal involvement. Three of these patients had bilateral kidney involvement, and the remaining two patients had unilateral lesions, which did not affect either the secretory or the excretory renal function (Table 1).

The degree of ^{18}F renal concentration bore no relation to renal function. There is, however, a strong indication that a majority of patients with unequal renal concentration of ^{18}F are likely to harbor a renal disease. Eleven of the 13 patients (84.6%) with

TABLE 1. SCAN INTERPRETATION OF ^{18}F RENAL CONCENTRATION COMPARED TO RESULTS OF OTHER STUDIES IN 16 PATIENTS WITH RENAL DISEASE

Scan category	No. of patients in each	Scan interpretation of kidney concentration	Results of other studies
O	1	Slight and equal concentration	Documented polycystic renal disease
	2	Slight and equal concentration	^{131}I -Hippuran renogram—impaired function both sides
	3	Slight and equal concentration	Documented metastases to both kidneys from breast cancer
	4	Slight and equal concentration	Autopsy—extensive metastases to both kidneys
	5	Slight and equal concentration	IVP—benign cyst, (L) kidney IVP—large peripelvic mass, (L) kidney
SU	1	Slight but (R) kidney concentrates $> \text{L}$	IVP—duplicate collecting system, (L) kidney
	2	Slight visualization of (L) kidney only	IVP and ^{131}I -Hippuran renogram—no function, (R) kidney
	3	Slight visualization of (L) kidney only	H/O, right nephrectomy for carcinoma
FU	1	Fair concentration in (R) kidney only	IVP—nonfunctioning (L) kidney
	2	Fair concentration in (L) kidney only	IVP—duplicate pelvis, (R) kidney
	3	Fair concentration $\text{L} > \text{R}$	IVP—calculus (L) kidney
	4	Fair concentration $\text{L} > \text{R}$	IVP—(R) sided dilatation and ureteric obstruction
MU	1	Marked concentration $\text{R} > \text{L}$	IVP—small (L) kidney, ^{131}I -renogram less function (L) kidney
	2	Marked concentration $\text{L} > \text{R}$	IVP—hydronephrosis and hydrouretic (L)
	3	Marked concentration in (R) kidney only	IVP—nonfunctioning (L) kidney
M + U	1	Marked concentration in (L) kidney and (L) ureter	^{131}I -Hippuran renogram—delayed excretion on (L) side

unequal ^{18}F concentration, in whom clinical and/or other studies were done, showed unilateral renal abnormalities (Table 1).

Correlation of ^{18}F kidney accumulation with other studies revealed that scan appearances were not helpful in locating the abnormal kidney (Table 1). The two patients with duplication of collecting system of one of the kidneys showed more ^{18}F concentration in the normal kidney, indicating a more efficient clearance of radioactivity from the kidney with a duplicate collecting system. Two patients, one each with a renal calculus and hydronephrosis, showed increased retention of ^{18}F in the involved kidney indicating impaired excretion. However, another patient with right ureteral dilatation and obstruction showed less retention of ^{18}F which was presumably due to impairment of the secretory function of the kidney.

SUMMARY AND CONCLUSIONS

Fluorine-18-fluoride bone scans performed on 160 consecutive patients were examined in retrospect to study the incidence and extent of ^{18}F accumulation in the kidneys. Pointers in clinical history and laboratory studies indicative of renal function and morphology were available from the hospital notes in 27 patients and were correlated to the degree and equality of ^{18}F renal concentration on the scans.

The following conclusions were made from the study:

1. Restriction of fluids for about 4 hr before injection of ^{18}F -fluoride resulted in absent or slight ^{18}F renal radioactivity in two-thirds of the patients, which would have otherwise interfered with the bone scan interpretation of the lumbar region.
2. Absence of ^{18}F concentration in the kidneys does not preclude renal disease.
3. The degree of ^{18}F concentration bears no relation to kidney disease.
4. A large majority of patients (84.6%) with unequal ^{18}F concentration in the kidneys showed unilateral renal abnormalities. None of the patients with equal concentration showed renal disease.
5. It was not possible to predict which of the two kidneys was involved in patients with unequal concentration of ^{18}F .

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