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SENSITIVITY OF ^{99m}TECHNETIUM-DIMERCAPTOSUCCINIC ACID FOR THE DIAGNOSIS OF CHRONIC PYELONEPHRITIS: CLINICAL AND THEORETICAL CONSIDERATIONS

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ABSTRACT

Radioisotopic renal imaging proved to be much more sensitive than excretory urography in diagnosing renal parenchymal damage in 6 children with acute febrile urinary tract infections. This increased sensitivity may affect clinical management. More importantly, it may change the interpretation of scientific studies evaluating the natural history and treatment of vesicoureteral reflux.

The excretory urogram (IVP) has been the traditional method of evaluating renal parenchymal damage in patients with vesicoureteral reflux.[1] Size, parenchymal thickness, caliceal configuration and rates of renal growth can be determined by an IVP. This information is useful not only for clinical decisions but also for formulating concepts on the natural history and pathophysiology of vesicoureteral reflux.[2-4]

We describe 6 patients with normal findings on an IVP in whom a ^{99m}technetium-dimercaptosuccinic acid (^{99m}Tc-DMSA) renal scan clearly documented renal injuries. We believe that the increased sensitivity of radionuclide imaging may lead to changes in the management of individual patients previously assessed by an IVP. More importantly, studies in the literature that depended on IVP findings to reach conclusions about the progression of renal disease associated with vesicoureteral reflux may be flawed.

PATIENTS

The 6 patients (3 boys and 3 girls 3 months to 7 years old) were selected from approximately 200 children with urinary tract infections, among whom a third had undergone an IVP and ^{99m}Tc-DMSA scan shortly after presentation. All 6 patients had documented vesicoureteral reflux after presenting with the first febrile urinary tract infection. Initial IVPs (all of relatively good quality) showed no evidence of upper tract damage, although concurrent ^{99m}Tc-DMSA scans revealed significantly decreased renal function and evidence of renal injury. The table provides the details of the degree of reflux, and findings on the IVP and ^{99m}Tc-DMSA scan. Of our 6 patients 3 were treated surgically with ureteral reimplantation and the others were followed with prophylactic antimicrobial agents, including anticholinergics in 1 case. Followup imaging studies confirmed the abnormalities seen on the initial ^{99m}Tc-DMSA nuclear scans.

Comparison of IVP with ^{99m}Tc-DMSA scan in the detection of renal damage in 6 children with vesicoureteral reflux

Pt.—Age—Sex No.	Normal Initial IVP	Degree of Reflux (International classification)	^{99m}Tc-DMSA	Therapy	Followup IVP
1—1 yr.—F	+	3	Decreased binding, rt. kidney	Antibiotics	Rt. scarring
2—4.5 yrs.—M	+	4	Markedly decreased binding, lt. kidney	Antibiotics	Lt. scarring
3—9 mos.—M	+ Bladder diverticula	3	Small rt. kidney	Surgery	Rt. scarring
4—3 mos.—M	+	4	Bilat. focal areas of decreased binding	Antibiotics	Bilat. scarring
5—3 yrs.—F	+	3	Markedly decreased binding, lt. kidney	Surgery	Lt. scarring
6—7 yrs.—F	+ Lt. duplicated system	3	Minimal binding, lt. lower pole	Surgery	Lt. lower pole scarring

Followup ^{99m}Tc-DMSA scans remained essentially unchanged (figs. 1 and 2).

DISCUSSION

Traditionally, the IVP has been the preferred study to evaluate pyelonephritic scarring. The criteria are well described, and most clinicians are familiar and comfortable with interpreting them. However, the IVP has some limitations, including the short nephrographic phase, the need for adequate perirenal fat for accurate resolution of renal outlines and, most importantly, interference from bowel gas and in cases of ectopic kidneys bony structures. These problems are particularly im-

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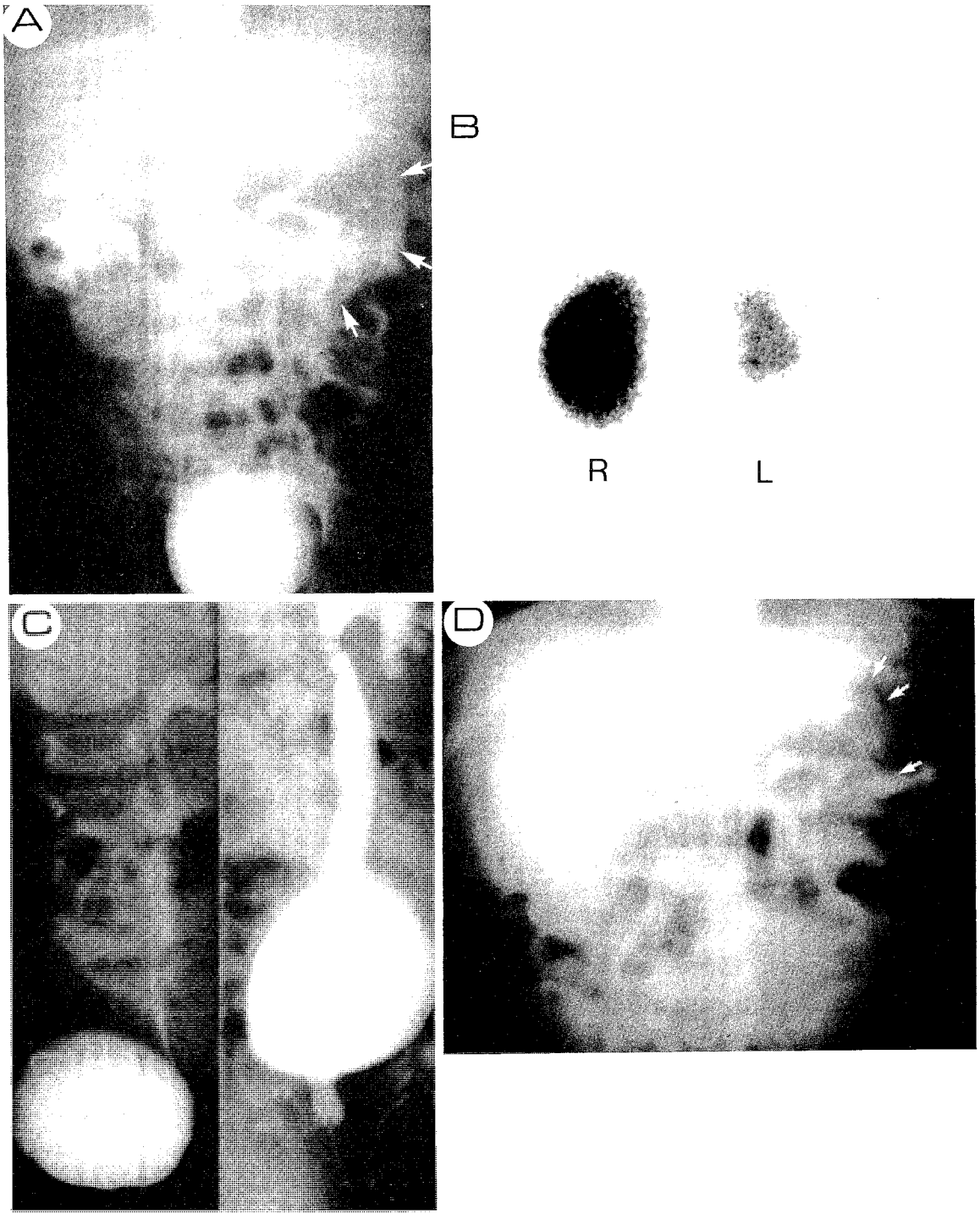

FIG. 1. Patient 2. *A*, normal IVP at presentation with febrile urinary infection. *B*, concurrent ^{99m}Tc-DMSA scan shows marked left renal injury. On posterior images right kidney has 92 per cent of counts. *C*, initial voiding cystourethrogram with high grade left vesicoureteral reflux. *D*, left renal scarring is now apparent on 1-year followup IVP.

portant in children, in whom poor cooperation, limited bowel preparation and abnormal kidneys are more common. Tomography can be helpful but its use is limited in children to prevent excessive radiation exposure. Furthermore, although the IVP gives excellent parenchymal and caliceal detail, the correlation between parenchymal damage and caliceal distortion is not optimal.[5,6]

In contrast, radioisotopic imaging,[7] although less familiar to the clinician, has proved to be helpful in diagnosing renal scarring. It is unaffected by bowel gas or overlying structures, avoids the risk of allergic reaction and entails lower radiation exposure (additional images can be obtained without additional exposure). Although caliceal anatomy is not seen, the renal parenchyma is delineated clearly, particularly when imaged with agents bound in the renal cortex.

Of more concern is the possibility that even an adequate IVP may not accurately demonstrate renal damage. In all 6 of our cases the IVP provided enough visualization to suggest normal kidneys, yet ^{99m}Tc-DMSA renal scanning clearly contradicted these findings and ultimately proved to be correct. In theory the radioisotope should fail to bind the injured parenchyma immediately after the injury, whereas radiographic scars are late sequelae, dependent on fibrous contractions or failure of growth, and may take years to become apparent.[8,9]

Many pediatricians believe that a normal IVP in a child with a febrile urinary tract infection argues against any further

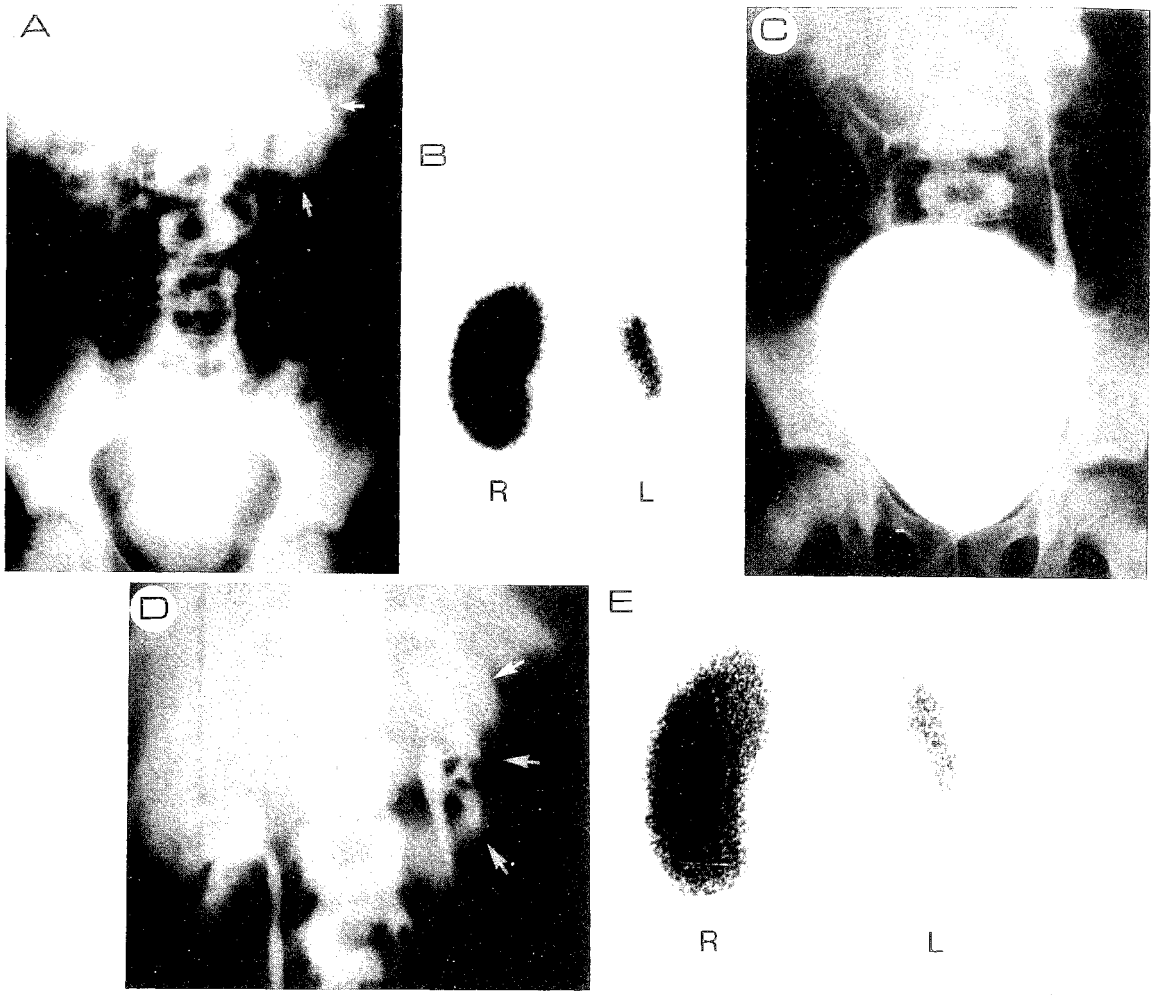

FIG. 2. Patient 5. *A*, normal IVP at evaluation for initial febrile urinary infection. *B*, concurrent ^{99m}Tc-DMSA scan reveals significant left renal damage (95 per cent of counts in right kidney on posterior images). *C*, voiding cystourethrogram demonstrates left vesicoureteral reflux. *D*, IVP 15 months after left ureteral reimplantation shows small left kidney. *E*, repeat ^{99m}Tc-DMSA scan 15 months postoperatively shows little change (96 per cent of counts in right kidney).

studies. They suggest that if no scarring has developed it is unnecessary to diagnose or to treat vesicoureteral reflux because future scarring is unlikely. We suggest extreme caution when using an IVP to conclude that no renal injury has occurred. If the clinician wishes to carry the "big bang" theory of pyelonephritis to the extreme, a radioisotopic scan seems essential.

All 6 of our patients had an acute febrile urinary infection, which is a typical presentation and one in which an IVP may initially fail to illustrate the renal injury. It would not be surprising to find instances when the scarring was finally observed on a later IVP from which one might incorrectly infer that treatment (operative or otherwise) failed to prevent "progressive" damage. Exactly this type of study has been reported in the literature, with data showing that 66 per cent of the children with some evidence of renal scarring at the time of ureteral reimplantation had apparently progressive scarring radiographically.[2] Indeed, this study often is quoted as an argument against surgical treatment of vesicoureteral reflux. Our findings refute this conclusion. In a number of instances of acute infection the IVP is insensitive to the initial renal injury, only documenting the late consequences. Even successful ureteral reimplantation cannot prevent the progressive pathological changes that will inexorably follow a significant renal injury. Although the scarring is demonstrated on the postoperative IVPs, the radioisotopic scans clearly show that the damage was done preoperatively. There is no evidence currently in the literature that conclusively demonstrates progressive renal damage from infection after successful ureteral reimplantation.

The sensitivity of radioisotopic scans for diagnosing chronic pyelonephritis suggests that these studies should be included whenever possible in evaluating children with vesicoureteral reflux, particularly at the time of the first febrile urinary tract infection. Most importantly, scientific investigations comparing various forms of treatment of vesicoureteral reflux should include radioisotopic studies (especially with cortical agents) for evaluating renal anatomy and function. Failure to do so may invalidate conclusions based on IVP findings alone.

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