Potential Pitfall of DMSA Scintigraphy in Patients with Ureteral Duplication

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A 5-wk-old male presented with radiographic findings of a duplicated collecting system. A [^{99m}Tc]DMSA scan was requested to evaluate cortical function. Images obtained immediately postinjection showed activity restricted to the upper poles; in contrast, delayed images at 4 hr showed activity in the bladder and throughout both kidneys. Catheterizing the patient drained the activity from the bladder but had little effect on the refluxed renal activity. The early [^{99m}Tc]DMSA images were critical in making the proper interpretation. Technetium-99m DMSA is excreted into the urine and this fact needs to be considered when interpreting scans of patients with possible reflux or obstruction. When DMSA scans are obtained in pediatric patients with possible reflux, catheterization prior to the study and early images prior to the appearance of DMSA in the collecting system are recommended.

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Duplication of the upper urinary tract collecting system is the most common anomaly of the genitourinary system (*1*). In complete ureteral duplication, the lower segment enters the bladder in a lateral position with a short intramural course and is prone to vesicoureteral reflux (*2*). In two thirds of the cases, ureteral reduplication is incomplete (*3*) and ureteroureteral reflux may occur in as many as 80% of cases (*4*). Severe reflux may be associated with a loss of cortical function in the affected renal segment. Appropriate therapy may consist of heminephrectomy and ureterectomy or ureteroneocystostomy; this frequently depends upon the residual function in the involved renal segment. Some investigators consider technetium-99m (^{99m}Tc) DMSA scintigraphy essential prior to heminephrectomy to evaluate cortical function (*5*). While a much greater percentage of [^{99m}Tc]DMSA is bound to the renal cortex than other scintigraphic agents, ~ 15% of the injected dose is excreted in the urine in the first 12 hr (*6*). Urine excretion of [^{99m}Tc]DMSA increases in acidotic rats and in patients with Fanconi's syndrome (*7,8*). The following case report illustrates a problem which can occur during DMSA scintigraphy of patients with duplication.

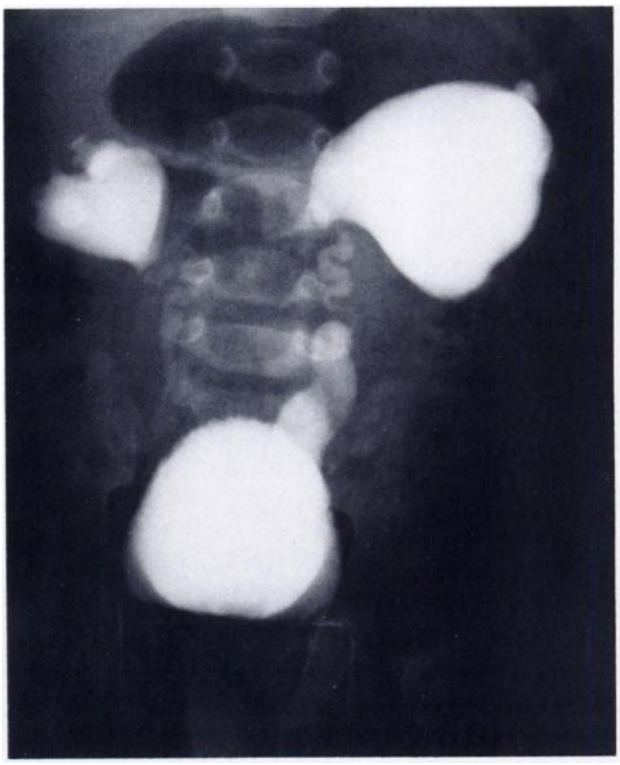

FIGURE 1
Voiding cystourethrogram (AP projection) on second day of life showed large, smoothly marginated bladder with low pressure vesicoureteral reflux on left and bilateral voiding vesicoureteral reflux into lower pole collecting systems bilaterally

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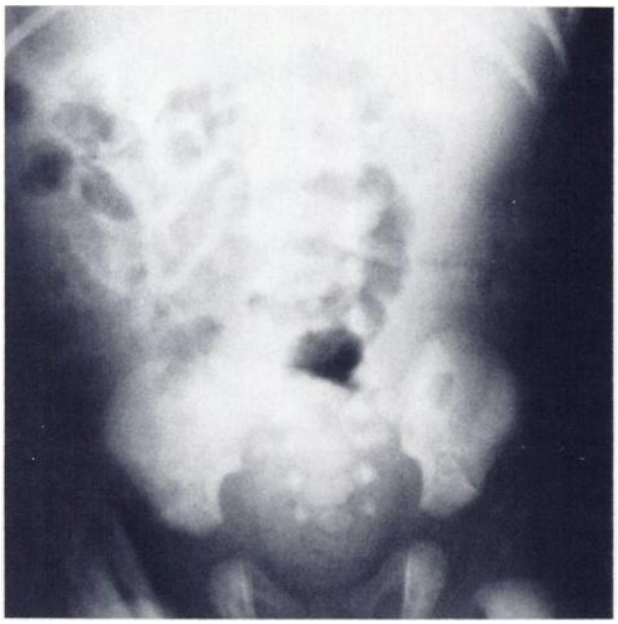

FIGURE 2
Intravenous urogram (AP projection) on third day of life showed normal bilateral upper poles. Ureters were not visualized

CASE REPORT

A 5-wk-old male with a serum creatinine of 0.7 mg/dl was noted to have hydronephrosis in utero by ultrasound. A repeat ultrasound examination performed on the first day of life confirmed the diagnosis. A voiding cystourethrogram obtained on the second day of life showed a large smoothly marginated bladder with low pressure vesicoureteral reflux on the left and bilateral voiding vesicoureteral reflux to hydronephrotic kidneys (Fig. 1). An i.v. urogram on the third day of life showed normal appearing upper pole calices bilaterally; the ureters were not visualized (Fig. 2). These combined findings were consistent with a duplicated collecting system (Fig. 2).

A DMSA scan was subsequently obtained to evaluate renal cortex function. The patient received an i.v. injection of 500 μCi of [^{99m}Tc]DMSA. A postinjection blood-pool image and 4-hr delayed images were obtained. All images were recorded on a computer for further processing. Markers were placed on the patient 5 cm apart at the time of delayed imaging. Based on the markers, the kidneys were estimated to have a length of 4–5 cm corresponding to the 4 cm length determined by ultrasound. The 4-hr images showed homogenous DMSA uptake by the kidneys suggesting uniform cortical function (Fig. 3). However, the bladder was prominently visualized and because of the possibility of reflux, the patient was catheterized. Repeat DMSA images showed only a minimal decrease in lower pole activity (Fig. 3). Nevertheless, since early DMSA images showed activity restricted to the upper poles (Fig. 4), computer subtraction of the early images from the delayed images was performed. The resulting image indicated that functioning cortex was restricted to the upper poles. The lower pole activity noted on delayed imaging represented reflux that did not clear after bladder catheterization.

DISCUSSION

Most duplication cases are incomplete with the ureters joining above their origin in the bladder. Such systems are prone to ureteroureteral reflux (*9–11*). Furthermore, pelviureteral obstruction of the lower moiety and vesicoureteral reflux into both ureters may be encountered (*5,10*). Complete duplication occurs when two ureteral buds arise from the Wolffian duct and this condition is also prone to vesicoureteral reflux (*2,5,10*),

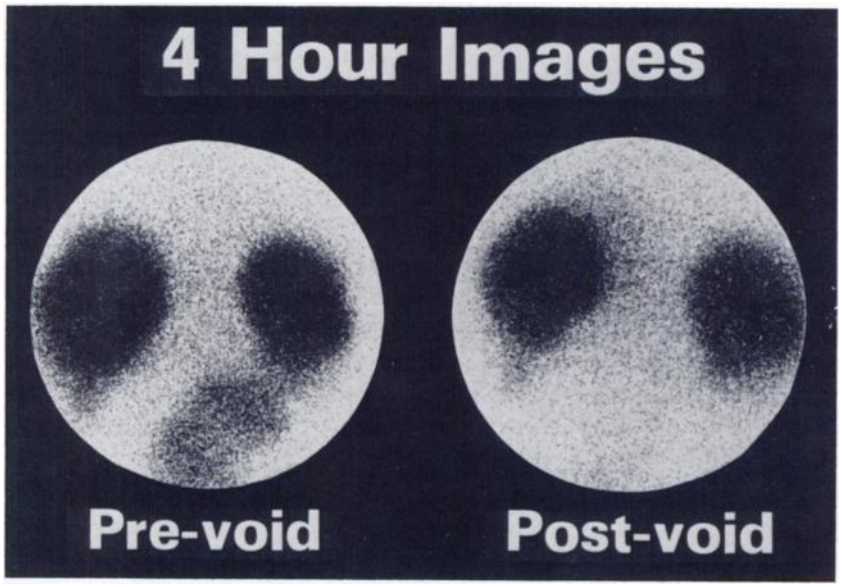

FIGURE 3
Four-hour [^{99m}Tc]DMSA images (posterior projection) indicate fairly homogeneous uptake by both kidneys; there was no significant change in renal configuration following catheterization

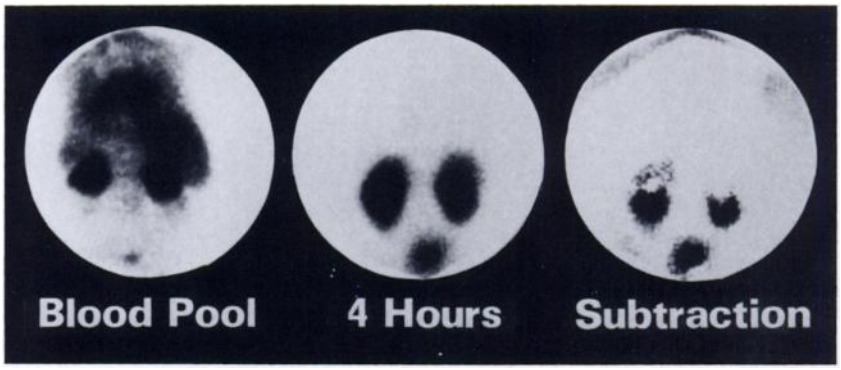

FIGURE 4
Early ^{99m}Tc images (posterior projection) obtained shortly after injection show activity which appears to be restricted to upper poles. Upper pole margin of kidneys on early images were aligned with upper pole margins on 4-hr delayed images using computer manipulation. Following alignment, subtraction image was obtained indicating that lower pole activity represented reflux

especially involving the lower pole moiety of the duplication (*2*).

Technetium-99m DMSA scintigraphy is recommended in the assessment of a possible nonfunctioning segment and is considered essential prior to hemine-phrectomy or corrective urologic surgery (*3*). Usually, the optimal imaging time for [^{99m}Tc]DMSA imaging is 1–4 hr after injection due to the low extraction efficiency of [^{99m}Tc]DMSA and the fact that ~ 50% of the injected dose localizes in the renal cortex (*6*). Restricting our imaging times to a 1–4 hr postinjection may well have led to a misinterpretation or a nondiagnostic study. Catheterizing the patient prior to the study may have prevented the reflux but it may not have been helpful in a patient with partial duplication and ureteroureteral reflux. In any case, knowledge of prior radiographic results is important in optimally planning a scintigraphic study. A 24-hr postinjection image was not obtained, but 24-hr imaging may have allowed enough time for the DMSA to wash out of the lower pole collecting system. In this patient, early [^{99m}Tc] DMSA images were critical in making the proper interpretation. Technetium-99m DMSA is excreted in the urine and this fact needs to be considered when interpreting scans with possible reflux or obstruction. When [^{99m}Tc]DMSA scans are obtained in pediatric patients with reflux, catheterization prior to the study and early images prior to the appearance of [^{99m}Tc]DMSA in the collecting system are recommended.

REFERENCES

1. Kelalis PP: Renal pelvis and ureter. In *Clinical Pediatric Urology*, Kelalis PP, King LR, Belman AB, eds., Philadelphia, W. B. Saunders, 1985, p 673
2. Fehrenbacker LG, Kelalis PP, Stickler GB: Vesicoureteral reflux and ureteral duplication in children. *J Urol* 107:862–864, 1972
3. Campbell JM: *Clinical Pediatric Urology*, Philadelphia, W. B. Saunders, 1951
4. Campbell JM: Ureteral peristalsis in duplex renal collecting systems. *Am J Roent Rad Ther Nuc Med* 99:577–584, 1967
5. Mella ST, Eckstein HB: The value of renal scintigraphy in reduplication. In *Radionuclides in Nephrology*, Joekes AM, et al., eds. London, Academic Press, Inc., 1982, pp 229–236
6. Taylor A, Jr: Quantification of renal function with static imaging agents. *Semin Nucl Med* 7:330–344, 1982
7. Yee CA, Lee HB, Blaufox MD: ^{99m}Tc-DMSA renal uptake: Influence of biochemical and physiologic factors. *J Nucl Med* 22:1054–1058, 1981
8. van Luyk WHJ, Ensing GJ, Piers DA: Low renal uptake of Tc-99m DMSA in patients with proximal tubular dysfunction. *Eur J Nucl Med* 8:404–405, 1983
9. Ash JM, Antico VF, Gilday DL, et al: Special considerations in the pediatric use of radionuclides for kidney studies. *Semin Nucl Med* 7:354–363, 1982
10. Ash JM, Gilday DL: Renal nuclear imaging and analysis in pediatric patients. *Urol Clin NA* 7:201–214, 1980
11. O'Reilly PH, Lawson RS, Shields RA, et al: A radioisotope method of assessing ureteroureteric reflux. *Br J Urol* 50:164–168, 1978