

Renal nuclear isotope study using dimercaptosuccinic acid in evaluating renal parenchymal changes in urinary tract infection in children

Rajashekarmurthy G Ramachandrappa, M L Keshavamurthy, M L Siddaraju

From Department of Paediatrics, Indira Gandhi Institute of Child Health, Bengaluru, Karnataka, India

Correspondence to: Dr. Rajashekarmurthy G Ramachandrappa, 2064, East End B Main Road, 38th Cross, Jayanagar 9th Block, Bengaluru - 560 069, Karnataka, India. Phone: +91-9845363345. E-mail: drrsm3@hotmail.com

Received – 26 November 2016

Initial Review – 14 December 2016

Published Online – 26 December 2016

ABSTRACT

Background: Urinary tract infections (UTI) are among the most common diseases in childhood. The diagnosis and management of complicated UTI are difficult. The renal cortical scintigraphy using dimercaptosuccinic acid (DMSA) has been reported to be useful in children for confirmation of the diagnosis and for localization of parenchymal changes in acute pyelonephritis with renal scars. **Objectives:** To assess the role of 99m Tc-DMSA in identifying renal scars due to UTI in children. **Materials and Methods:** This study was a hospital-based prospective study conducted from November 2014 to October 2015. 53 children admitted with the first episode of the culture proven UTI. Children with vesicoureteric reflux or congenital renal anomalies were excluded from the study. All the patients were subjected to 99m Tc-DMSA. **Results:** An abnormal renal scan was observed in 28 out of 53 children (52.83%). The most common organism isolated was *Escherichia coli* (75.4%). All the children had fever (100%) followed by dysuria/increased frequency (50.94%). The majority of the renal parenchymal changes confined to the upper poles followed by lower poles and mid poles. Left kidney was involved more commonly (56%) than the right kidney (44%), whereas 3 children had bilateral involvement (10.71%). Parenchymal changes were common among children in 2-5 year age group (46.4%) followed by in children more than 5 years. **Conclusion:** DMSA renal scan has confirmed the high incidence of radiographically demonstrable renal scars in a significant number of children. It has helped to define parenchymal involvement in the form of pyelonephritic scars, the most common complication of UTI which is preventable.

Key words: Renal isotope scan, Urinary tract infection, Dimercaptosuccinic acid

Urinary tract infection (UTI) is among the least commonly diagnosed bacterial infections of childhood [1]. The term UTI refers to a clinical entity that may involve the urethra and/or bladder (lower urinary tract); and the ureters, renal pelvis, calyces, and/or renal parenchyma (upper urinary tract) [2]. UTI is a common problem in daily practice with prevalence probably second to respiratory tract infections [3].

Even though urine is readily accessible for examination, the diagnosis and management of UTI may not always be easy [3]. The prevalent studies have shown that UTI may often be missed on history and physical examination, and the decision to screen for UTI must balance the risk for missed infections with the cost and inconvenience of testing [1]. In addition to routine urine testing, urine culture is a “confirmatory gold standard” for the diagnosis. A positive urine culture indicates infection anywhere in the urinary tract [4]. The variable and nonspecific presentation in children more so in infants [5], with a potential for renal parenchymal damage, makes childhood UTI a concern.

Early parenchymal infection or changes may not be detected by ultrasound or intravenous pyelography. This is better delineated by renal isotope studies such as dimercaptosuccinic acid (DMSA) scan [6]. UTI may be the first sign of a genito-urinary tract

abnormality, the first attack of UTI in infancy and early childhood is usually not a single attack but beginning of a continuous process with the risk of recurrences [7]. The goal of UTI care is to treat and prevent progressive damage to renal parenchyma. This study aims to assess the role of 99m Tc-DMSA in identifying renal scars due to UTI in children.

MATERIALS AND METHODS

This prospective study was conducted over a period of 1-year at Vani Vilas Children Hospital, Bengaluru, Karnataka, which is a tertiary care teaching hospital and nuclear medicine wing attached to the Department of Radiodiagnosis of Bangalore Medical College and Research Institute. Prior approval from the Institutional Ethical Committee was taken. Consent from parents/guardians was obtained before recruitment.

All children with the first episode of UTI and who had documented culture positive UTI were enrolled in the study. Urine culture was done by taking suprapubic aspirate from the children with suspected UTI. Other relevant investigations such as complete blood count and C-reactive protein were done in addition. Those with recurrent UTI or vesicoureteral reflux (in

micturating cystourethrogram) were excluded from the study. A total of 53 children were enrolled and were subjected to 99m Tc-DMSA nuclear studies within 7 days of their diagnosis of UTI. After 6 weeks, same children were subjected to 99m Tc-DMSA nuclear studies to look for the persistence of photopenia. Various demographic parameters, clinical features, investigation results, and final diagnosis were entered in a pretested pro forma. This is an observational study to know only the incidence of the scar.

RESULTS

A total of 53 children enrolled, out of which 5.6% were <2 years (3 females), 47.1% were between 2 and 5 years (15 females, 10 males), 28.3% were between 5 and 10 years (10 females, 5 males), and 18.8% were more than 10 years (7 females, 3 males). The most common presenting complaint was fever which was present in all 53 (100%) children followed by dysuria/increased frequency in 27 (50.94%) children. Abdominal pain was present in 24 children (45.28%) and vomiting/poor feeding in 23 (45%) children. The majority of the isolated organism in urine culture was *Escherichia coli* (75.4%), followed by *Klebsiella pneumoniae* (20.75%), and coagulase positive and coagulase negative staphylococci in 1 (1.89%) case each.

DMSA renal scan results showed a majority of the renal parenchymal changes were confined to the upper poles (57.14%) followed by involvement of lower (24.42%) and mid poles (11.30%). Both upper and lower poles had parenchymal changes in 7.14% cases. 18 (64.29%) females had abnormal DMSA compared to 10 (35.71%) males. 13 (46.43%) children between 2 and 5 years had parenchymal changes, whereas 7 (25%) children each of 5-10 years and >10 years age group had parenchymal changes. Least affected children (3.57%) were those <2 years of age.

An abnormal renal scan was observed in 28 of 53 children (52.83%), of these 25 (89.29%) children had unilateral involvement, whereas 3 (10.71%) children had bilateral involvement. As shown in Table 1, left kidney was involved more (56%) as compared to the right kidney (44%), whereas 3 (10.71%) children had bilateral involvement. The total DMSA abnormality among the study population was 52.83% (Table 1).

DISCUSSION

In this study, culture positive female children outnumbered males. In a study by Biggi et al., out of 101 children with UTI, 60 were

female children 41 were males [8]. In study by Nammalwar et al., 42 children with culture positive UTI, 25 children were female and 17 were males [4]. In all these studies, there was a female preponderance. However, in our study, 5.6% of the children were <2 years whereas it was 45.2% in another study [4]. This may be because of the presence of VUR below 2 years in their study [4]. The majority of the children were in the age group of 2-5 years (47.1%) in our study because we have excluded VUR (Micturating Cystourethrogram was done in those children with repeated UTI). Hence, the percentage may be low in younger age group.

In our study, fever was the most common symptom followed by dysuria/increased frequency and abdominal pain which are consistent with other studies [9]. *E. coli* was the most common organisms found in our study (75.47%) followed by *Klebsiella* (20.75%) which is comparable with other studies [10-12]. Our study is mainly to know the incidence of renal pathology in the form of the scar, and we did not make an attempt to correlate between renal parenchymal pathology and clinical features of fever and causative organisms like other studies where they found all fever more than 38.5°C had abnormal DMSA [13]. Stockland et al. found a positive correlation between temperature and abnormal DMSA in their study. A temperature of 38.5°C or higher found to have 92% sensitivity to get an abnormal DMSA [14].

A strong correlation among UTI and renal scarring has been established with the available data, overwhelmingly support the acquired origin of renal scars in association with bacterial UTI [15]. Our study showed that scars can develop even without VUR. This was contrary to common belief that VUR is a prerequisite for scarring. Infection can alone produce scars. This was similar to the other studies [15-18].

Vanderfaulle et al. [19] documented 61% of abnormal DMSA are over 5 years of age, whereas in our study, it was 50% followed by 2-5 years of age group. Age is generally considered an important risk factor for the development of renal damage with younger children reported to greater risk than older children [20,21]; however, this was not evident in our study. It should be noted that only one child was below 2 years of age in our study. Our study was consistent with the other studies [22,23] showing that children with scars were significantly older at the time of infection.

Acute renal lesions were distributed between upper, mid and lower poles whether reflux is present or not. Topographic analysis of the lesions in our study is on par with studies done by Banador et al. [23] which showed that 41% were localized to upper poles and 31% to the lower poles, 28% to the mid poles. The left kidney was more frequently involved than right kidney in our studies which is similar to the other studies [8,22].

In our study, the incidence of the renal scar was shown to be 52.83% with the use of DMSA scan. It may be argued that higher detection rate of abnormalities at DMSA scintigraphy could be due to associated VUR present in their studies [4,24]. Our study has limitation due to small number of sample size. Second, even

Table 1: Results of DMSA renal scan in relation to kidney (n=53)

DMSA findings	Number (%)
Normal	25 (47.17)
Abnormal	28 (52.83)
Unilateral	25 (89.29)
Right kidney	11 (44.00)
Left kidney	14 (56.00)
Bilateral	3 (10.71)

DMS: Dimercaptosuccinic acid

higher detection rate of abnormality at DMSA could have been achieved if high-resolution technique including double head detector had been used.

REFERENCES

- Zorc JJ, Kiddoo DA, Shaw KN. Diagnosis and management of pediatric urinary tract infections. *Clin Microbiol Rev.* 2005;18(2):1417-22.
- Moriarty RA. Urinary tract infections. In: Gershon A, Hotez P, Katz N, editors. *Krugman's Infectious Diseases of Children.* 11th ed. Philadelphia, PA: Mosby; 2004.
- Gulati S, Kher V. Urinary tract infection. *Indian Pediatr.* 1996;33(8):211-7.
- Nammalwar BR, Vijayakumar M, Sankar J, Ramnath B, Prahlad N. Evaluation of the use of DMSA in culture positive UTI and culture negative acute pyelonephritis. *Indian Pediatr.* 2005;42(7):691-6.
- Alexander KC, Leung M, Lane W, Robson M. Urinary tract infection in infancy and childhood. *Adv Pediatr.* 1991;38:257-77.
- Walsh PC, Retik AB, Vaughn ED. In: Campbell, editor. *Text Book of Campbell's Urology.* 8th ed. London: Elsevier; 2005. p. 151-61.
- Mehta KP. Urinary tract infection. *Indian Pediatr.* 1996;33:173-6.
- Biggi A, Dardanelli L, Pomerio G, Cussino P, Noello C, Sernia O, et al. Acute renal cortical scintigraphy in children with a first urinary tract infection. *Pediatr Nephrol.* 2001;16(9):733-8.
- Smellie JM, Shaw PJ, Prescod NP, Bantock HM 99mTc dimercaptosuccinic acid (DMSA) scan in patients with established radiological renal scarring. *Arch Dis Child.* 1988;63(11):1315-9.
- Burns MW, Burns JL, Krieger JN. Pediatric urinary tract infection. Diagnosis, classification, and significance. *Pediatr Clin North Am.* 1987;34:1111-20.
- Maherzi M, Guignard JP, Torrado A. Urinary tract infection in high-risk newborn infants. *Pediatrics.* 1978;62(4):521-3.
- Yousaf M, Khan HH. Organisms causing UTI in pediatric patients. *West J Med.* 1992;157:554-61.
- Goldman M, Bistrizer T, Horne T, Zoareft I, Aladjem M. The etiology of renal scars in infants with pyelonephritis and vesicoureteral reflux. *Pediatr Nephrol.* 2000;14(5):385-8.
- Stokland E, Hellström M, Jacobsson B, Jodal U, Sixt R. Renal damage one year after first urinary tract infection: Role of dimercaptosuccinic acid scintigraphy. *J Pediatr.* 1996;129(6):815-20.
- Winter AL, Hardy BE, Alton DJ, Arbus GS, Churchill BM. Acquired renal scars in children. *J Urol.* 1983;129(6):1190-4.
- Arnold AJ, Brownless SM, Carty HM, Rickwood AM. Detection of renal scarring by DMSA scanning – An experimental study. *J Pediatr Surg.* 1990;25(4):391-3.
- Kass EJ, Fink-Bennett D, Cacciarelli AA, Balon H, Pavlock S. The sensitivity of renal scintigraphy and sonography in detecting nonobstructive acute pyelonephritis. *J Urol.* 1992;148:606-8.
- Majd M. Radionuclide imaging in pediatrics. *Pediatr Clin North Am.* 1985;32(6):1559-79.
- Vanderfaëillie A, Flamen P, Wilikens A, Desprechins B, Piepsz A. Technetium-99m-dimercaptosuccinic acid renal scintigraphy in children over 5 years. *Pediatr Nephrol.* 1998;12(4):295-7.
- Pykkänen J, Vilksa J, Koskimies O. The value of level diagnosis of childhood urinary tract infection in predicting renal injury. *Acta Paediatr Scand.* 1981;70(6):879-83.
- Berg UB, Johansson SB. Age as a main determinant of renal functional damage in urinary tract infection. *Arch Dis Child.* 1983;58(12):963-9.
- Jakobsson B, Nilstedt L, Svensson L, Söderlundh S, Berg U 99mTechnetium-dimercaptosuccinic acid scan in the diagnosis of acute pyelonephritis in children: Relation to clinical and radiological findings. *Pediatr Nephrol.* 1992;6(4):328-34.
- Benador D, Benador N, Slosman DO, Nusslé D, Mermillod B, Girardin E. Cortical scintigraphy in the evaluation of renal parenchymal changes in children with pyelonephritis. *J Pediatr.* 1994;124(1):17-20.
- Mahapatra G. Scintigraphic detection of early scarring in acute pyelonephritis in children using DMSA imaging agent. *Indian J Nucl Med.* 1990;5(4):27-30.

Funding: Children admitted to Vani Vilas Children Hospital attached to Bangalore Medical College and Research Center; Conflict of Interest: None Stated.

How to cite this article: Ramachandrappa RG, Keshavamurthy ML, Siddaraju ML. Renal nuclear isotope study using dimercaptosuccinic acid in evaluating renal parenchymal changes in urinary tract infection in children. *Indian J Child Health.* 2017; 4(1):61-63.