

Detection of Congenital Renal Anomalies in Children being Investigated by Tc99m-DMSA Renal Scan

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ABSTRACT

Objective: To describe various types of congenital renal anomalies incidentally detected during routine DMSA scan in children with urinary tract infection, and to compare the incidence of scarring in patients with and without renal anomalies.

Methods: This study included 400 subjects (138 boys and 262 girls), age range (one month to 15 years / Mean= 5.6 years). In the period between May to December 2009, children were referred to Nuclear Medicine Center for Tc 99m DMSA scan to rule out renal scarring. Congenital anomalies appearance, scarring and function of kidneys were documented. Pearson correlation was used in statistical analysis and P<0.05 was considered significant.

Results: There were 55 cases of congenital kidney anomalies in our study (13.75%), within 29 boys and 26 girls. The most common congenital anomaly was single kidney seen in 17 cases (4.25%). Renal scarring was detected in 31.25% of total cases (125 cases out of 400 cases), 30.9% of congenital anomalous kidneys (17 out of 55 cases), and in 31.3% of non-anomalous kidneys (108 out of 345 cases).

Conclusion: Congenital renal anomalies are not uncommon. Tc 99m DMSA scan is an adequate imaging modality to detect these anomalies and assess renal scarring. Patients with congenital anomalies did not show an increase in renal scarring compared to non-anomalous kidneys.

Key words: Tc99m- DMSA, Congenital renal anomalies, Scarring, Renal scan.

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Introduction

Renal tract malformations are a clinically challenging collection of entities because of their diversity, and the fact that these disorders can present both before and after birth. The most severe anomalies can be devastating, resulting in neonatal renal failure and death. At the other extreme, some of the milder, more common anomalies can have a benign course. Each patient with a renal tract malformation, therefore, needs an individualized clinical approach, which might require diverse investigational modalities, most important of which is Tc99m DMSA cortical scan.⁽¹⁾

Being common in children, about 1-2% of boys and 3-7% of girls experience at least one episode of urinary tract infection (UTI) before the age of 11 years. Assessment of renal parenchymal damage resulting from acute or chronic renal infection is the primary indication for radionuclide imaging with Tc-99m DMSA.⁽²⁾ In addition, this technique allows congenital anomalies and permanent renal scarring to be identified. The aim of this study was to assess various types of congenital renal anomalies detected during routine DMSA scan in children with UTI by describing the appearance of such anomalies. Furthermore, we compared the incidence of scarring in patients with and without renal anomalies.⁽²⁻⁴⁾

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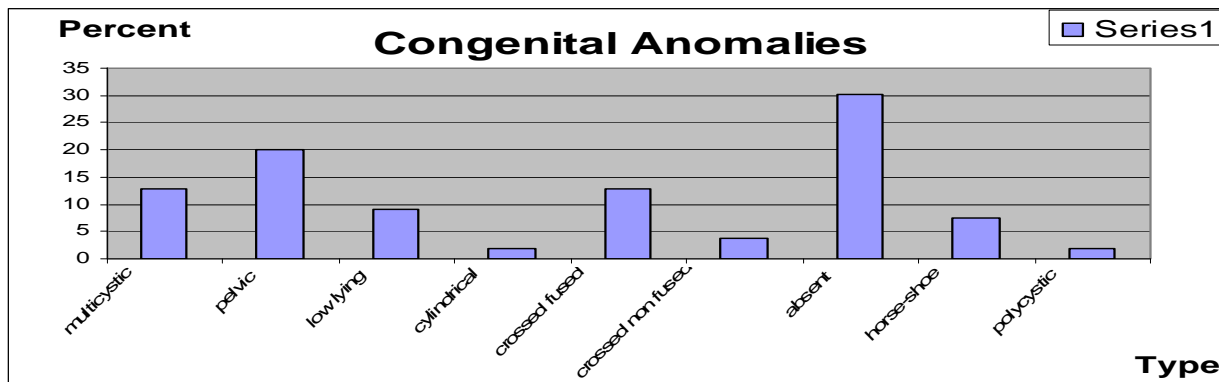


Fig. 1. Types of Renal Congenital Anomalies Reported

Table I. Percentage of different anomalies and incidence of scarring

Congenital Anomaly	Total	Scarred	% of scarring	% from total cases	% from anomalies
Absent	17	0	0	4.25	30.2
Pelvic	11	9	81.8	2.75	20.1
Crossed Fused	7	4	57	1.75	12.8
Multicystic	7	0	0	1.75	12.8
Low lying	5	1	20	1.25	9.2
Horse-Shoe	4	2	50	1	7.4
Crossed Non Fused	2	1	50	0.5	3.7
Cylindrical	1	0	0	0.25	1.9
Polycystic	1	0	0	0.25	1.9

Methods

This study included 400 children (138 boys and 262 girls), aged one month to 15 years (Mean 5.6 years). All children had UTI, and were referred for the Nuclear Medicine Center at King Hussein Medical Center for DMSA renal scan in the period from May to December 2009, to assess for possible renal scarring. All patients had DMSA scan conducted two to three hours after intravenous injection of Tc99m- DMSA radiopharmaceutical, with calculated dose according to body weight. A posterior, anterior and two posterior oblique images of the kidneys were acquired, with the patient supine on a dedicated dual head Millennium Gamma Camera.

The renal scintigraphic patterns were independently interpreted by two senior nuclear-medicine physicians, and the criteria used for the interpretation of the images regarding renal scars and congenital anomalies did not change during the period of the investigation. A kidney with normal size, regular shape and a tracer uptake that appeared to be homogenous was considered as normal. Single or multiple wedge shaped cortical defects, focal or diffuse photopenic patterns in one kidney with or without contraction and loss of volume in the involved cortex were considered as abnormal and indicating scarring.^(5,6) The normal position of the

kidney was taken into consideration for assessment of ectopia.

Cases were classified as normal kidneys with regard to position and shape irrespective to scarring, and kidneys with otherwise congenital anomalies noted, namely: single kidney, pelvic kidney, multicystic kidney, crossed fused ectopia, low lying kidneys, horse-shoe kidney, crossed non-fused ectopia, cylindrical kidney and polycystic kidneys.

Pearson correlation was used to determine the statistical significance of the relationships between variables studied: scarring in patient with or without renal congenital anomalies. The Pearson correlation was determined (r value), and a P value below 0.05 was considered statistically significant.

Results

There were 55 cases of congenital renal anomalies in our study (13.75%), within 29 boys and 26 girls. The most common congenital anomaly encountered was single kidney which appeared in 17 cases accounting for 4.25% of total cases (30.2% of anomalies). The second most common was pelvic kidney, seen in 11 accounting for 2.75% incidence from total cases (20.1 % of congenital anomalies). Multicystic kidney and crossed fused ectopia had the same percent with 7 cases each accounting for the same percent: 1.75% each. Low lying kidneys



Fig. 2. This is a 3 year old boy who presented for evaluation of possible renal scarring after an episode of UTI. There was absent radiotracer uptake in the right kidney indicating absent kidney (proved by U/S) with normal uptake in the left kidney and no evidence of scarring.

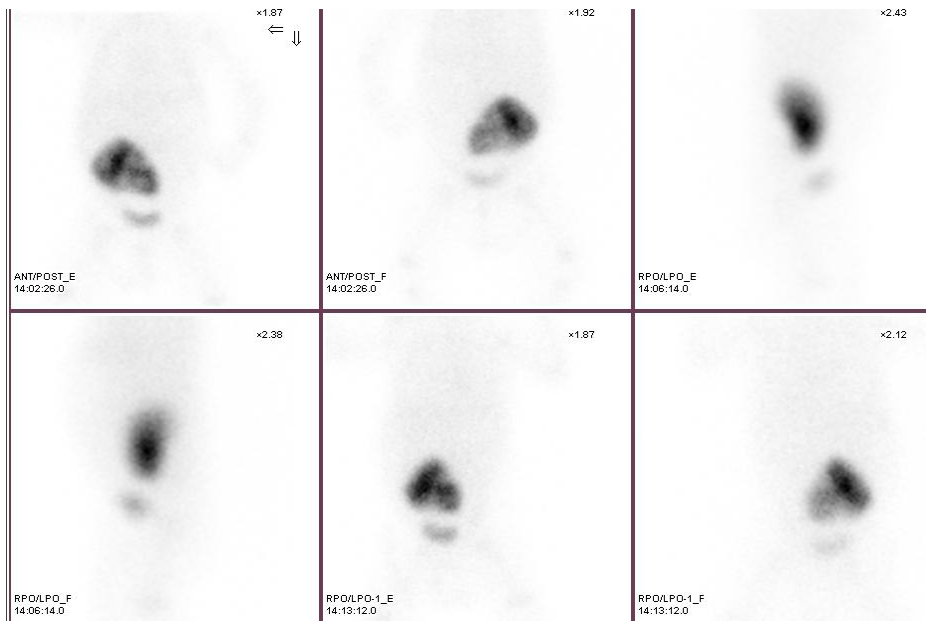


Fig. 3. In a 5 year-old female with UTI, DMSA renal scan showed the left kidney crossing the midline to the right side and fused with the right kidney.

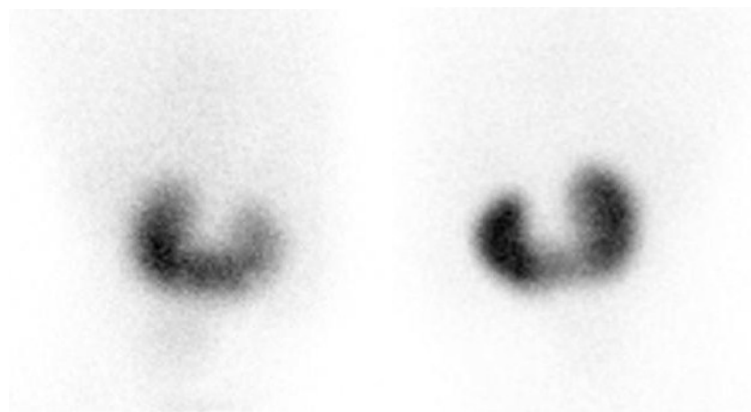


Fig. 4. These are images from a 3 year old boy who presented post an attack of UTI. There is regular radiotracer cortical uptake in both kidneys which appear to be connected in their lower poles with a functioning isthmus: configuration of Horse-shoe kidney

were considered in cases with kidneys lying lower than the contralateral but still not pelvic, these accounted for 1.25 % seen in 5 cases. Horse-shoe kidney accounted for 1% (4 cases). Kidneys crossing the midline and not fused with the other kidney (crossed non-fused ectopia) was seen in 0.5% of cases (2 cases). One case of cylindrical kidney (0.25%) and one case of polycystic kidneys (0.25%). (Fig. 1, Table I)

The other factor studied other than anomalies of the kidneys, was presence of renal scarring. This was considered scintigraphically as any size of cortical wedge defect, diffuse thinning of cortex or smaller size shrunken kidney.^(5,6) These findings were approved by two senior nuclear medicine specialists in the department. Renal scarring was detected in 31.3% of non-anomalous kidneys (108 of the 345 cases), and 30.9% of congenital renal anomalies (17 of the 55 cases). The Pearson product-moment correlation coefficient was used to determine the relation between the two groups. Pearson Correlation was ($r = 0.075$) indicating insignificant statistical difference in the incidence of scarring between the two groups with an equivalent P value = 0.133.

Discussion

UTI is common in children. About 1-2% of boys and 3-7% of girls experience at least one episode of UTI before the age of 11 years.^(6,7) Assessment of renal parenchymal damage resulting from acute or chronic renal infection is the primary indication for radionuclide imaging with Tc-99m DMSA.^(1,2,4) It is a more sensitive modality compared to IVU and ultrasound in the evaluation and follow up of kidneys at risk for scarring in children, and allows congenital anomalies to be identified.^(2,3,7) Tc-99m DMSA is taken up specifically in the tubular cells of the renal cortex and facilitates assessment of function and identification of aberrantly located kidneys, and the assessment of outcome of urinary tract infection or VUR, namely cortical scarring.⁽⁸⁾ Although some authors mention the low yield of positive results on the management in children more than one year of age.^(9,10)

Unilateral renal agenesis is not uncommon and usually is accompanied by ureteral agenesis with absence of the ipsilateral trigone and ureteral orifice. No treatment is necessary; compensatory hypertrophy of the solitary kidney maintains normal renal function.⁽¹¹⁻¹³⁾ A similar entity, renal aplasia, is evident by absent activity on DMSA scan with the

presence of renal parenchyma by ultrasound.^(3,10,14) In the 400 cases we reviewed, 17 cases of congenitally absent kidney were found, non of which showed any cortical scarring in the contralateral kidney. This finding encouraged us to hypothesize that a single kidney as isolated congenital anomaly doesn't increase the risk of cortical scarring. (Fig. 2).

Embryologic development of crossed renal ectopia has not been clearly determined but many theories have been offered to explain this congenital anomaly. It is suggested that mechanical factors are of primary importance in ectopia without fusion. Being more frequent in males (M/F = 1.4/1), crossed renal ectopia is two to three times more common on the right than on the left.^(11,15) In our study of the 9 cases of crossed ectopia (fused and non-fused) 7 cases were situated on the right and only 2 cases on the left side. The condition is generally diagnosed in the third decade. Crossed fused ectopia appear to be more prevalent in our study population compared to crossed non-fused ectopia (12.8% of congenital anomalies compared to 3.7% for crossed non-fused ectopia), which is also the case in other reviews.^(15,16) (Fig. 3)

Horse-shoe kidney occurs when renal parenchyma on each side of the vertebral column is joined at the corresponding (usually lower) poles; an isthmus of renal parenchyma or fibrous tissue joins at the midline (Fig. 4). The ureters course medially and anteriorly over this isthmus and generally drain well.^(11,17) In our review we had 7 cases, contributing to 7.4% of total renal anomalies. Of these non showed any renal scars, suggesting no clinical relevance between this entity and incidence of scarring.

Multicystic kidney was observed in 7 cases, contributing to 12.8% of renal anomalies in our study population (Fig. 5). In this condition, a nonfunctioning renal unit consists of non-communicating cysts with intervening solid tissue composed of fibrosis, primitive tubules, and foci of cartilage. Usually, ureteral atresia is also present. Uncommonly, the kidney develops tumors or infection, and hypertension may develop. Most experts recommend observation, although some advocate removing these kidneys.^(3,11,18)

Renal ectopia, abnormal renal location, usually results when a kidney fails to ascend from its origin in the true pelvis (Fig. 6); a rare exception occurs with a superiorly ascended (thoracic) kidney.⁽¹⁹⁾ Pelvic ectopia increases the incidence of

Table II. Frequency of scarring in anomalous kidneys and normal situated (non-anomalous) kidneys, and percent of scarring taking into account the total number and the number of each group

	Number of cases	% from total N=400	% from specific group
Total Scarred from non-anomalous kidneys	108	27.0	31.3 (from non-anomalous kidneys: N=345)
Scarred anomalous kidneys	17	4.25	30.9 (from anomalous kidneys: N=55)
Total	125	31.25	

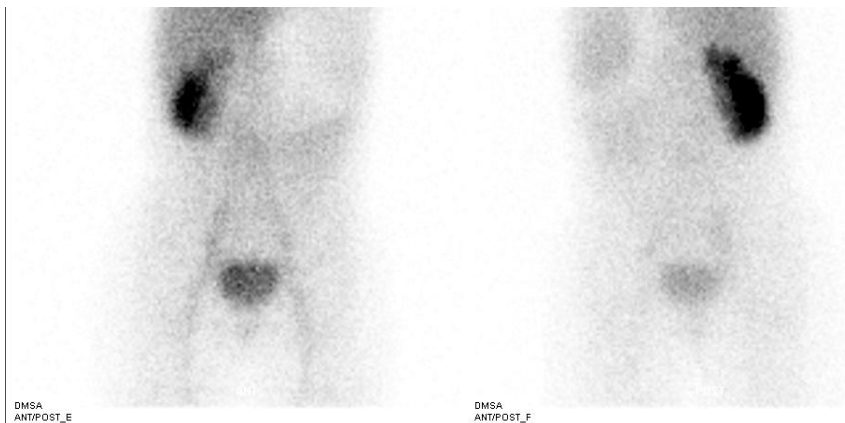


Fig. 5. Multicystic left Kidney in a 7 year old boy who presented with UTI. Ultrasound of the same boy showed an enlarged left kidney with multiple large cysts. DMSA scan showed absent radiotracer uptake in the left kidney establishing the diagnosis of non-functioning Multicystic Kidney.

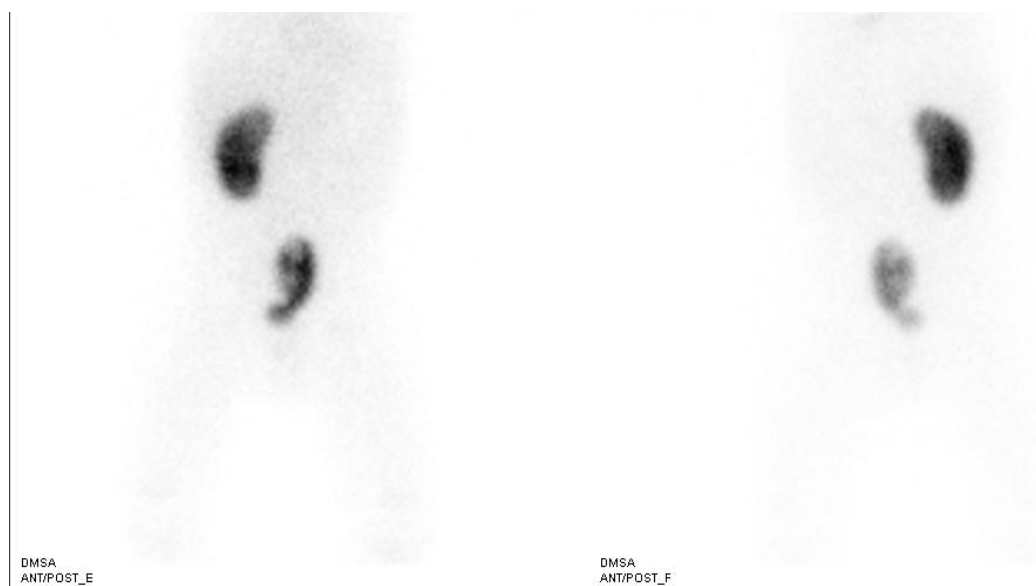


Fig. 6. Post proved UTI in a 2 year old female .The left kidney appears ectopic in position (pelvic), small in size with irregular cortical outline due to multiple cortical scarring.

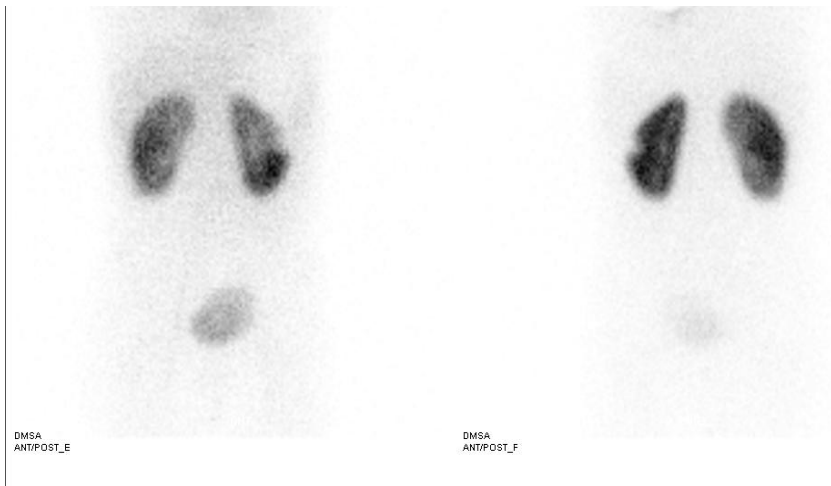


Fig. 7. A single wedge shaped cortical defect in a 9 year old boy with UTI, representing a cortical scar in the lateral border of the left kidney.

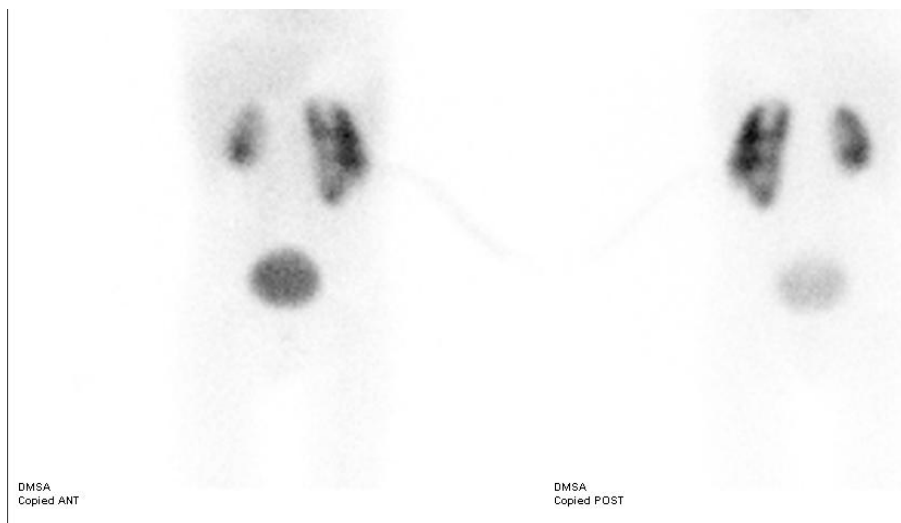


Fig. 8. A 12 year old female with neurogenic bladder and recurrent episodes of UTI. The right kidney appears small and shrunken due to multiple recurrent scarring. Left kidney also shows multiple cortical defects in the upper and lower poles

ureteropelvic junction obstruction, vesicoureteral reflux, and multicystic renal dysplasia. Obstruction is corrected surgically. Severe reflux can be corrected surgically when indicated (if causing hypertension, recurrent infections, or renal growth retardation).^(1,3) The incidence of renal scarring is increased in pelvic kidney compared to other renal anomalies. In our study pelvic kidneys accounted for 20.1% of total anomalies (11 cases), of these 81.8% were scarred (9 cases). We noticed the right kidney to be more liable to failure of ascendance as 8 cases of the 11 pelvic kidneys affected the right side.

During reviewing the 400 cases, scarring (evident by single or multiple wedge shaped cortical defect, diffuse cortical thinning or shrunken small kidney) was noted in 31.25% of all cases (125 cases), 31.3% of normal situated kidneys (non- anomalous) (108

cases) and 30.9 % of congenital anomalies (17 cases) (Fig. 7, 8). These results appear to be statistically insignificant in regard to renal scarring incidence. Although some congenital anomalies as single entities had increased incidence of scarring, taking congenital anomalies as an entire assembly was not associated with increased incidence of parenchymal insult and cortical scarring in our study. (Table II)

Conclusion

Congenital renal anomalies are usually diagnosed when other disease states are being investigated during DMSA scan, namely chronic or acute urinary tract infections. This scan can be helpful in assessment and follow-up of kidney functions as well as assessment of renal scarring. Patients with

congenital anomalies, as entire assembly, did not show any increase in incidence of renal scarring compared to normal kidneys.⁽²⁰⁾

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