



ACCURACY OF ULTRASOUND DETECTION OF RENAL SCARRING AT QRH USING DMSA AS THE GOLD STANDARD

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ABSTRACT

Introduction: Renal ultrasound (US) and dimercaptosuccinic acid (DMSA) scintigraphy are key diagnostic tools for detecting renal scarring. While US is non-invasive, its sensitivity is limited, whereas DMSA, the gold standard, achieves sensitivity rates exceeding 90%. This study evaluates the accuracy of US compared to DMSA in pediatric patients to inform clinical decision-making and reduce unnecessary radiation exposure. **Methods:** This retrospective study included 346 pediatric patients who underwent both renal US and DMSA scintigraphy at Queen Rania Abdallah Hospital from November 2019 to October 2023. Patient demographics, imaging indications, and findings were analyzed. US performance was assessed against DMSA, focusing on sensitivity, positive predictive value (PPV), and diagnostic accuracy. Subgroup analyses were conducted based on age, gender, and clinical indication. **Results:** Ultrasound detected scarring in 162 of 393 affected renal units, compared to 346 identified by DMSA, yielding a sensitivity of 46.69% and a PPV of 100%. Sensitivity varied by subgroup: males (57.67%) outperformed females (36.96%), and infants (<2 years, 53.25%) outperformed preschool children (42.61%). Conditions like atrophied kidney and ureter stricture showed 100% sensitivity, while ectopic and polycystic kidneys showed none. Bilateral scarring was missed in 87% of cases by US. **Conclusions:** Ultrasound's limited sensitivity and high false-negative rate underscore the necessity of DMSA for confirmatory diagnosis, particularly in high-risk cases. While US is valuable for initial screening, DMSA ensures accurate detection and optimal management of pediatric renal conditions. Future studies should refine imaging protocols and address dataset limitations to enhance diagnostic accuracy.

KEYWORDS: Renal scarring, Renal ultrasound (US), dimercaptosuccinic acid (DMSA) scintigraphy.

INTRODUCTION

Renal ultrasound (US) and dimercaptosuccinic acid (DMSA) scintigraphy are widely used diagnostic tools for evaluating renal pathology, especially in identifying renal scarring. Despite ultrasound's non-invasive nature, its sensitivity for detecting functional changes associated with renal scarring is limited, with reports indicating a sensitivity range of 30-60%.^[1,2] In contrast, DMSA scintigraphy is considered the gold standard for detecting renal scarring, with sensitivity rates often exceeding 90%.^[3] DMSA can identify both acute and chronic renal parenchymal damage, distinguishing itself by pinpointing areas with diminished or absent radiotracer uptake.

This study retrospectively compares the accuracy of renal US and DMSA scintigraphy in detecting renal scarring among pediatric patients at Queen Rania Abdallah Hospital. We aim to assess the feasibility of

using renal US as an initial, non-invasive screening tool while identifying clinical situations in which DMSA remains essential. Through this analysis, we hope to guide clinical decision-making to reduce unnecessary radiation exposure while maintaining diagnostic accuracy.

METHODOLOGY

After obtaining the institutional review board ethical approval, this retrospective study reviewed pediatric patient records at Queen Rania Al-Abdallah Hospital from November 2019 to October 2023. Children who underwent both renal US and DMSA scintigraphy during this period were included, with DMSA scintigraphy serving as the gold standard for detecting renal scarring.^[4] Data collected included patient demographics (age, gender), clinical indications for imaging, and relevant medical history. Exclusion criteria included anatomical anomalies, morbid obesity, or non-febrile

urinary tract infections (UTIs), which could compromise ultrasound accuracy.

Imaging Procedure and Analysis

All renal ultrasounds were performed by an experienced pediatric radiologist and were analyzed alongside DMSA scintigraphy results. Ultrasound findings were documented per renal unit and compared with DMSA results to evaluate the sensitivity, specificity, and diagnostic accuracy of ultrasound in identifying renal scarring. Comparative analysis included categorization by renal unit involvement (unilateral or bilateral) and etiology (e.g., VUR, UTI, congenital abnormalities). Statistical analyses were performed to assess the false-negative rate of ultrasound relative to DMSA.

RESULTS

A retrospective analysis included 346 pediatric patients at Queen Rania Abdallah Hospital who underwent both renal ultrasound and DMSA scintigraphy between November 2019 and October 2023. The mean age of presentation was 5.2 years, with a gender distribution of 53% female (184) and 47% male (162).

Table 1 summarizes the study indications, including hydronephrosis, vesicoureteral reflux (VUR), and recurrent urinary tract infections (UTIs), which were the most common imaging reasons. In total, 393 renal units

were affected. Ultrasound detected scarring in 162 units, while DMSA scintigraphy identified scarring in 346 units, showing a high rate of missed cases by ultrasound (Table 2). Ultrasound missed scarring in 41% of right-sided cases (79 out of 135 detected by DMSA) and 54% of left-sided cases (78 out of 172 detected by DMSA). For cases involving bilateral renal scarring, ultrasound detected only 5 cases, while DMSA identified 39, leading to an ultrasound miss rate of 87% for bilateral involvement.

Subgroup analysis revealed varying diagnostic performance across different demographics and clinical indications. In gender-based analysis, sensitivity was higher in males (57.67%) compared to females (36.96%), with a positive predictive value (PPV) of 100% in both groups. Age-based analysis demonstrated the highest sensitivity in infants (<2 years, 53.25%), followed by school-age children (>5 years, 46.45%), and the lowest sensitivity in preschool children (2–5 years, 42.61%). Indication-based analysis showed the highest sensitivities for conditions such as atrophied kidney, ureter stricture, and right pyeloplasty (all 100%), while ectopic kidney, polycystic kidney, and posterior urethral valve had no cases detected by ultrasound (0% sensitivity). These findings highlight significant variability in ultrasound performance, reinforcing the necessity of DMSA scintigraphy in critical cases.

Table 1:

Indication	Number of cases	US	DMSA
left ureter stone	1	YES	YES
Atrophied right kidney:	1	YES	YES
Bilateral HN	1	RT POSITIVE	RT POSITIVE
bilateral renal Stones	1	LT POSITIVE	LT POSITIVE
Bilateral VUR	68	33 no scare 18 positive LT 15 POSITIVE RT 3 BOTH	31 POSITIVE LT 21 POSITIVE RT 15 BOTH
ectopic left	2	No	2 Positive
Ectopic right	2	No	2 Positive
HN	6	2 NO 2 RT POSITIVE 2 LT POSITIVE	3 RT POSITIVE 3 LT POSITIVE
horseshoe	2	NO	1 POSITIVE RIGHT 1 POSITIVE bilateral
Left double moiety	1	No	Yes
Left HN	6	5 Positive	6 Positive
left puj obstruction	2	2 Positive	2 Positive
Left ureter implantation	1	Yes	Yes
Left VUJO	2	1 Positive	2 positives
left VUR	48	24 no scarring 19 positive left 3 positive rt 2 positive both	43 positive left 2 positive RT 3 positive both
Neurogenic Bladder	7	2 NO scarring 3 positive RT 1 positive left 1 positive both	3 positive RT 2 positive LT 2 POSITIVE both

polycystic kidney	1	No	Positive left
PUV	1	NO	POSITIVE LEFT
Recurrent UTI	89	58 NO SCAR 16 Positive Rt 15 positive LT	34 RT positive 44 LT positive 11 BOTH
renal Stones	3	2 no scar 1 left positive	2 left positive 1 RT positive
Right pyeloplasty	2	2 positive rt	2 positive rt
Right PUJO	1	Yes	Yes
Right HN	3	1 no scar 2 positive	3 positive
Right renal artery stenosis	1	NO	POSITIVE RT
Right ureter stricture	1	Yes	Yes
Right VUJO	1	POSITIVE RT	POSITIVE RT
right VUR	35	16 RT POSITIVE 19 NO scarring	31 RT positive 3 left positive 2 both
VUR	47	22 no scare 14 rt positive 11 LT positive	21 RT positive 21 LT positive 5 both positive
VACTERL	1	POSITIVE LT	POSITIVE LT
Small right	1	Yes	Yes
Small left	4	3 NO 1 positive lt	4 positive
Small kidneys	1	No	Both positive
Ureter implantation	1	No	Positive RT
right ureter implantation	1	No	Positive RT

Table 2:

Method	RT POSITIVE	LT POSITIVE	BOTH positive
US	79	78	5
DMSA	135	172	39
False-negative	41 %	54%	87 %

Table 3: Number and Percentage of patients according to the etiology.

	US Positive	DMSA Positive	% of US Positive Scan
Kidney stones	3	5	60%
Atrophied kidney	3	7	42.8%
Ectopic Kidney	0	4	0%
Horseshoe kidney	0	2	0%
VUR	114	219	52.1%
UTI (and pyelonephritis)	31	89	34.8%
PUJO	5	5	100%
PUV	0	1	0%
VUJO	2	3	66.7%
VACTERL	1	1	100%
Neurogenic bladder	5	7	71.4%
Polycystic Kidney	0	1	0%
Renal Artery Stenosis	0	1	0%
Ureter Stricture	1	1	100%

DISCUSSION

This study demonstrates the limited sensitivity of renal ultrasound for detecting renal scarring in comparison to DMSA scintigraphy, underscoring the need for caution in using ultrasound as a standalone diagnostic tool. While ultrasound is valuable as an initial, non-invasive screening option due to its accessibility and lack of

radiation, our results show it missed a substantial proportion of scarring cases. This is particularly true for bilateral involvement, with an overall sensitivity of approximately 46%, a finding consistent with previous studies.^[5, 6]

The statistical analysis underscores the diagnostic challenges of renal ultrasound in detecting scarring, as evidenced by a sensitivity of 46.69% and a high false-negative rate. The perfect PPV (100%) reflects the absence of false positives, yet this is counterbalanced by the inability to identify true negatives, rendering specificity and negative predictive value undefined. These results emphasize the need for DMSA scintigraphy as an essential confirmatory tool in high-risk cases. Future studies should consider more balanced datasets to allow comprehensive evaluation of all diagnostic metrics.

Ultrasound's limited sensitivity stems from its inability to capture functional details detectable by DMSA, which often achieves sensitivity rates exceeding 90%.^[3,7] In our study, ultrasound's sensitivity of 46% meant a high false-negative rate, particularly in cases involving recurrent UTI and VUR. These results reinforce the necessity of using DMSA as the gold standard for accurate renal scarring assessment in pediatric patients, especially in high-risk cases.

The findings align with studies by Christian *et al.*^[10] and Moorthy *et al.*^[11], which similarly reported ultrasound's high specificity but low sensitivity in detecting early or minor scarring. Shaikh *et al.*'s systematic review further supports DMSA's reliability in screening for VUR among children with UTIs^[13], and our data corroborate this, showing ultrasound's limitations, especially in recurrent UTI and VUR cases.

The data support a protocol where ultrasound serves as an initial, non-invasive screening tool, with DMSA reserved for cases where there is a high clinical suspicion of renal scarring or inconclusive ultrasound findings. This approach helps balance non-invasive assessment with diagnostic accuracy, ensuring effective management of pediatric renal conditions while minimizing unnecessary radiation exposure.

The study's retrospective design introduces certain limitations, such as potential variations in imaging quality and timing. Additionally, as the study was conducted in a specialized hospital setting, the findings may differ in less specialized facilities. Future prospective studies, ideally multi-center with standardized protocols, are warranted to validate these results and refine imaging guidelines.

In conclusion, while ultrasound offers benefits for initial assessment, DMSA scintigraphy remains essential for accurately diagnosing renal scarring, especially in high-risk cases. An integrated imaging approach that maximizes the diagnostic advantages of each modality is essential for optimal patient care.

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