Renal Study Using Speckle Reduction Imaging

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In the kidney, ultrasound has long been an effective tool for the diagnosis of collecting system obstruction (hydronephrosis and hydroureter) and for cystic and solid renal masses. It has been less effective for the diagnosis of acute diffuse renal diseases such as pyelonephritis, interstitial nephritis and glomerulonephritis. Recent advances in ultrasound imaging that improve tissue contrast including harmonic imaging and speckle reduction imaging have the potential to improve the diagnosis of diffuse processes—especially pyelonephritis which is usually multifocal rather than completely diffuse in nature. The following case illustrates the usefulness of a new form of speckle reduction technology called Speckle Reduction Imaging (SRI) from GE Healthcare when coupled with advanced tissue harmonic imaging.

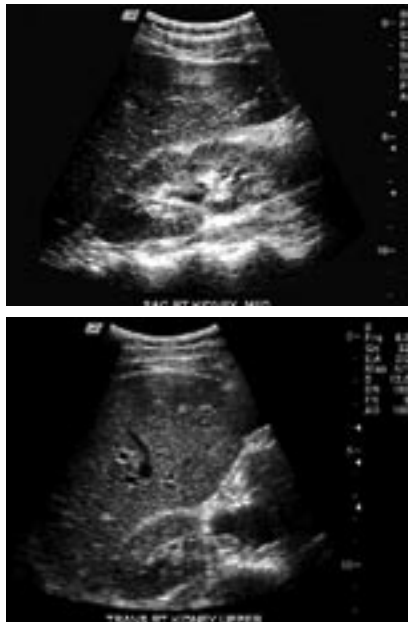

Figure 1.
Longitudinal image of the right kidney and transverse image of the right upper pole showing slight heterogeneity but no abscess or definite evidence for parenchymal abnormality. No hydronephrosis or calculi were seen.

Patient History

A 19–year–old white female patient appeared in the emergency department with a chief complaint of right flank pain with red blood cells being detected in her urine on dipstick analysis. She was referred to the ultrasound division to rule out a kidney stone and/or hydronephrosis.

Renal Ultrasound

A retroperitoneal ultrasound was performed and although the kidneys appeared slightly heterogeneous (figure 1); the study was finally interpreted as being normal without hydronephrosis or calculi.

A renal colic CT scan was subsequently performed as the etiology of the patient's flank pain and hematuria was still undetermined. The renal colic (non contrast enhanced) showed slight heterogeneity of the right kidney so the patient was returned for a contrast enhanced renal CT scan. This scan demonstrated multiple focal areas of diminished or absent enhancement consistent with pyelonephritis (figure 2).

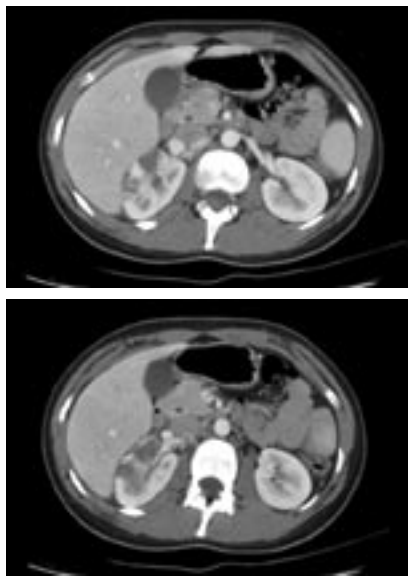

Figure 2.
Two contrast enhanced CT scans showing patchy diminished enhancement in the anterior upper right kidney. Compare with the normally enhancing left kidney.

The patient then returned to ultrasound for additional images using broadband harmonics and SRI. Even knowing that the upper right kidney was abnormal, finding the abnormality on fundamental images without speckle reduction was challenging (figure 3).

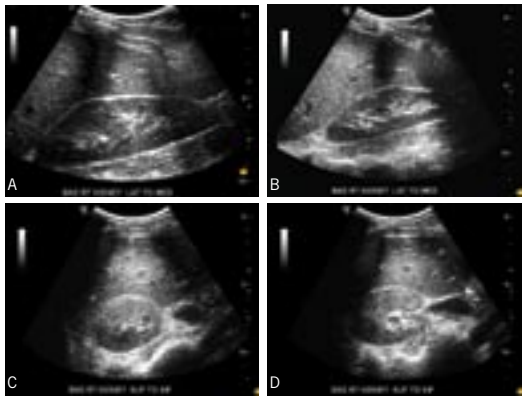

Figure 3.

Longitudinal images of the right kidney without harmonics or SRI (3A, 3B). As in figure 1, no convincing areas of increased or decreased echogenicity are seen. The transverse images (3C, 3D) show slightly increased echogenicity anteriorly but the finding is subtle and could be interpreted as being due to a focal zone being centered at the depth of the anterior part of the kidney.

Review of tissue harmonic images taken prior to the CT without SRI showed similar findings. Some images showed slightly increased echogenicity anteriorly but the changes were not quite bright enough or reproducible enough to be interpreted as abnormal (figure 4).

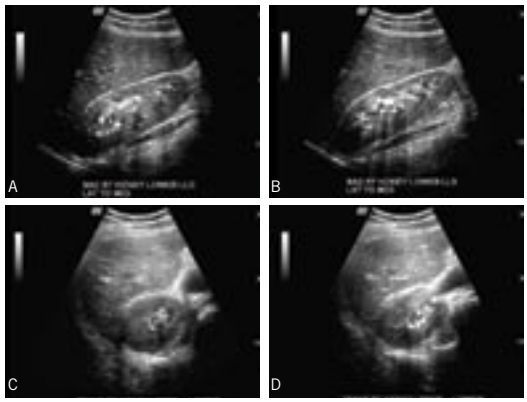

Figure 4.

Longitudinal tissue harmonics images (4A, 4B) and transverse images of the upper pole (4C, 4D) show slightly increased focal echogenicity anteriorly on some images, but the finding is very subtle and possibly is due to TGC settings or shadowing of the posterior cortex by the renal hilus. the finding is subtle and could be interpreted as being due to a focal zone being centered at the depth of the anterior part of the kidney.

On images obtained with SRI at an intermediate setting (setting 3), speckle is decreased and areas of abnormality now appear in the upper pole and mid kidney anteriorly as focal areas of increased echogenicity (figure 5). The areas of increased echogenicity are more clearly demarcated than on the fundamental images and are heterogeneous making them suspicious for focal pyelonephritis.

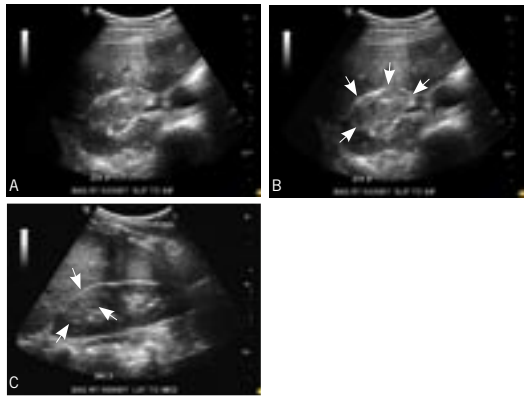

Figure 5.

Two transverse images of the right kidney using SRI at setting 3 (5A and 5B) show increased echogenicity more clearly anteriorly (arrows) interspersed with some focal hypoechoic areas. The increased echogenicity is heterogeneous making it less likely to represent a focusing effect and more likely to represent pathology. The longitudinal image also using SRI (5C) clearly shows increased echogenicity in the upper anterior right kidney (arrows).

By adding tissue harmonic imaging and SRI together, a dramatic improvement in the visibility of areas involved with focal pyelonephritis is achieved. The areas of increased echogenicity become accentuated, and heterogeneity within the abnormal areas is more readily appreciated (figure 6).

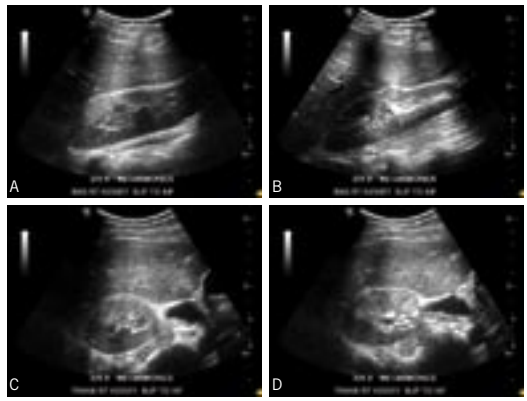

Figure 6.

Longitudinal (6A, 6B) and transverse (6C, 6D) images of the right kidney using both tissue harmonic imaging and SRI at setting 3. Note the markedly increased contrast between the echogenic infected kidney parenchyma anteriorly and the somewhat hypoechoic normal kidney posteriorly. Also note the considerable heterogeneity of the abnormal renal parenchyma that is readily visible.

An SRI setting of 3 is an intermediate setting the decreases but does not eliminate speckle. The maximum setting of 6 nearly completely

eliminates speckle and can further increase tissue contrast. The images taken with tissue harmonics and an SRI setting of 6 show as expected the focal parenchymal abnormalities as well or better than an SRI setting of 3 (figure 7).

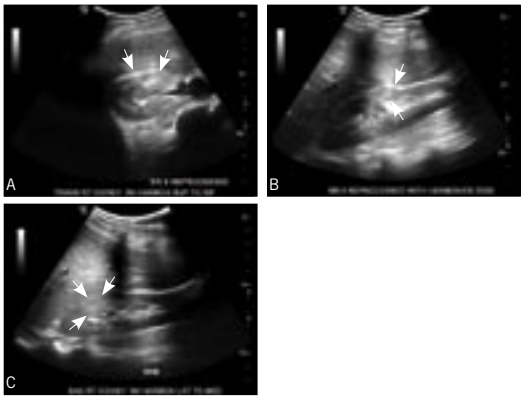

Figure 7.

Transverse (7A) and longitudinal images (7B, 7C) of the right kidney with tissue harmonics and maximum SRI setting. Note the virtual absence of speckle and the high contrast of the echogenic abnormal renal parenchyma (arrows).

A greater advantage of maximum SRI is that it increases the lower contrast abnormalities seen when using fundamental imaging (figure 8).

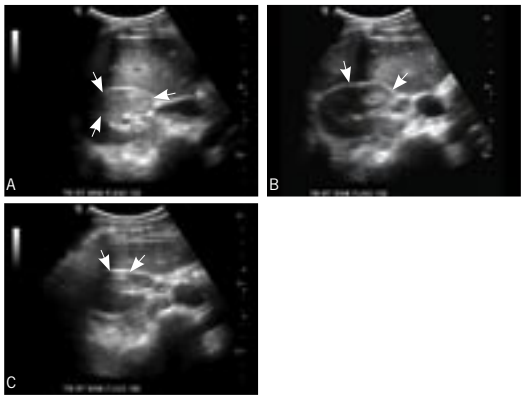

Figure 8.

Three transverse images without harmonics processed with maximum SRI setting (setting 6) show increased contrast of the focal parenchymal lesions anteriorly (arrows) compared to SRI (setting 3) and no SRI (compare to figures 3 and 5).

Discussion

The above case illustrates the potential of SRI for improved detection of parenchymal lesions of the kidney. Pyelonephritis may present as enlargement of the kidney, as focal areas of increased echogenicity[1] or as areas of decreased echogenicity—depending on the stage at which the infection is detected. As illustrated in this case, gray scale fundamental imaging of the kidney in an insensitive test for detection of pyelonephritis and because of this, power Doppler imaging has been tried, aiming to detect the decrease local perfusion that accompanies pyelonephritis[2]. Power Doppler is very motion sensitive however and is also somewhat insonation angle dependent making it difficult to use in children and less sensitive at the poles where the insonation angle to major intrarenal vessels is close to 90 degrees. "Multiple studies have shown that power Doppler cannot match the sensitivity of nuclear medicine (NM) or computed tomography (CT) for the detection of acute pyelonephritis[3, 4]. This case demonstrates how two newer technologies can be combined to markedly increase the sensitivity of sonography for pyelonephritis. Tissue harmonic imaging alone provides slightly increased contrast – a finding that has been previously reported[5]. SRI alone, by reducing speckle noise, increases contrast sufficiently for some of the parenchymal changes to be seen although the changes can be subtle. The combination of SRI and harmonics makes the changes strikingly apparent thus increasing the diagnostic certainty of the sonologist.

Because this case was sent for evaluation for possible stones and hydronephrosis, the sonographer and sonologist should be alert to the possibility of occult pyelonephritis being present in patients with flank pain. Tissue harmonics and SRI should be applied in all such cases to help exclude the possibility of infection. Further studies to validate these findings in larger numbers of patients are underway. With further experience, it may be possible using these techniques, to match the sensitivity of CT and NM for the detection of acute pyelonephritis.

[1]Morin D;VeyracC;Kotzki PO;Lopez C;Dalla Vale F; Durand MF; Astruc J; Dumas R. Comparison of ultrasound and dimercaptosuccinic acid scintigraphy changes in acute pyelonephritis. Pediatr Nephrol 1999 Apr;13(3):219-222.

[2]Bykov S; Chervinsky L; Smolkin V; Halevi R; Garty I . Power Doppler sonography versus Tc-99m DMSA scintigraphy for diagnosing acute pyelonephritis in children: are these two methods comparable? Clin Nucl Med 2003 Mar;28(3):198-203

[3]Berro Y; Baratte B; Seryer D; Boulu G; Slama M; Boudailliez B; Fonroget J; Grumbach Y . Comparison between scintigraphy, B-mode, and power Doppler sonography in acute pyelonephritis in children. J Radiol 2000 May;81(5):523-7.

[4]Dacher JN; Pfister C; Monroc M; Eurin D; Le Dosseur P . Power Doppler sonographic pattern of acute pyelonephritis in children: comparison with CT. AJR Am J Roentgenol 1996 Jun;166(6):1451-5 .

[5]Kim B;Lim HK; Choi MH; Woo JY; Ryu J; Kim S; Peck KR. Detection of parenchymal abnormalities in acute pyelonephritis by pulse inversion harmonic imaging with or without micro-bubble ultrasonographic contrast agent: correlation with computed tomography. J Ultrasound Med 2001 Jan:20(1):5-14.

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