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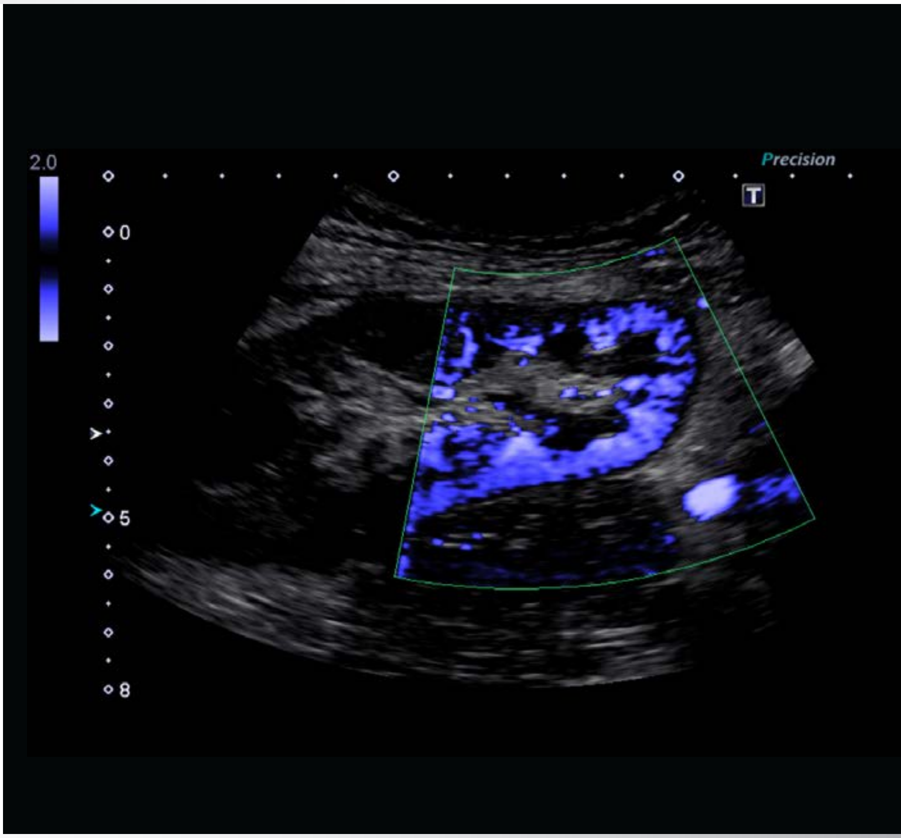

Toshiba's Superb Micro-vascular Imaging:

A New Problem-Solving Tool in Pediatric Radiology

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Superb Micro-Vascular Imaging (SMI) is the latest in a series of technological advances in diagnostic ultrasound imaging from Toshiba, giving clinicians a more accurate and rapid diagnosis. SMI builds upon the high-resolution and superior image quality made available on the Aplio 500™ ultrasound system and offers new capabilities in vascular imaging, all without using contrast. The ability to resolve fine details with the Aplio 500 is especially important when caring for pediatric patients.

SMI is an innovative ultrasound Doppler technique. It works by employing a proprietary algorithm to remove clutter artifacts while maintaining sensitivity to low blood flow velocities. As shown in Figure 1, conventional color Doppler imaging utilizes a wall filter to remove clutter artifacts caused by background tissue motion. Traditional wall filters are unable to distinguish clutter artifacts from true low velocity flow, so true flow is removed from the image. SMI preserves low blood flow velocities while removing clutter artifacts and also features high frame rates and high resolution (Figure 2). SMI operates in two modes: monochrome SMI (mSMI), which subtracts the background image from the detailed vasculature, and color SMI (cSMI), which displays the flow components in color overlaid on the grayscale B-mode image.

SMI helps clinicians to visualize very small vascular structures and observe small branching details that previously were not visible. SMI does not use intravenous contrast, which is a significant advantage for pediatric patients, who are often fearful of needles and injections. The high frame rates and reduced flash artifacts enabled by SMI make imaging active young children easier by shortening exam times and improving workflow.

Recently, I had the opportunity to evaluate SMI in the ultrasound clinic of Cincinnati Children's Hospital Medical Center. The following images were selected to highlight the potential clinical impact of SMI in pediatric radiology. The greater detail and visualization of small branching vessels are illustrated in the cSMI image of the liver from a young patient, as compared with the color Doppler image (Figure 3).

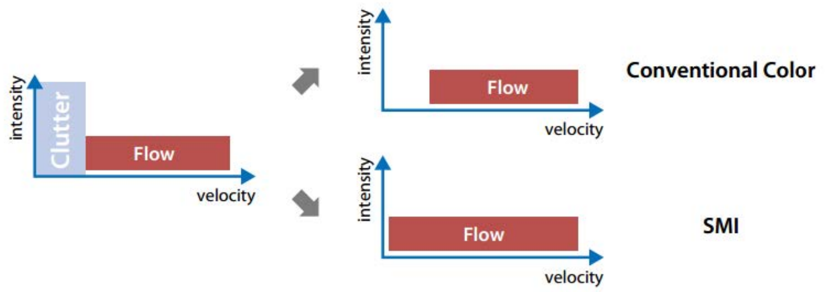

Figure 1. Illustration of the differences between conventional color Doppler imaging and SMI.

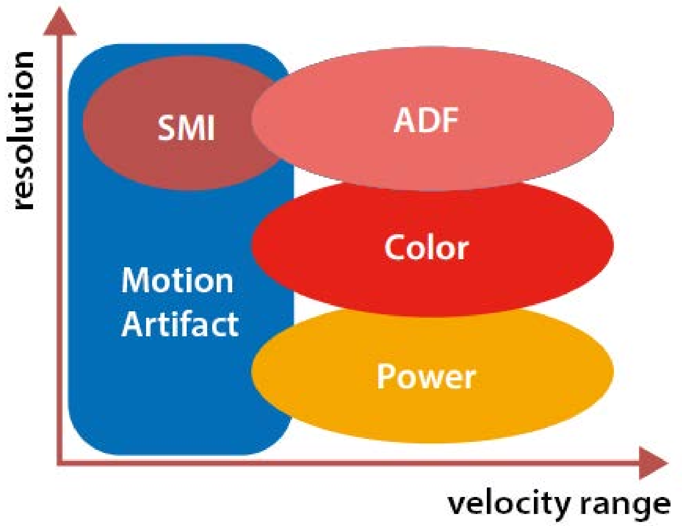

Figure 2. SMI features high resolution and better sensitivity to low-velocity blood flow than existing Doppler technologies.

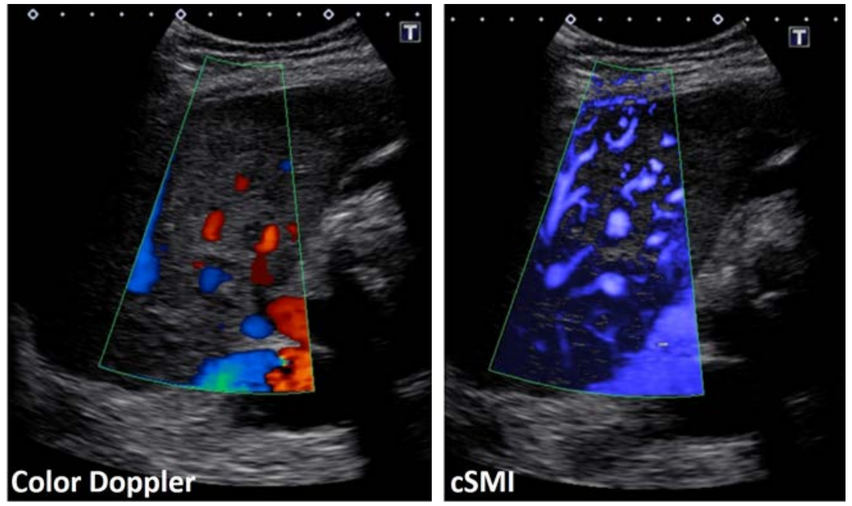

Figure 3. Side-by-side comparison of color Doppler (left) and cSMI (right) from the liver of a young patient. cSMI shows greater detail and better visualization of small branching vessels.

mSMI focuses on the blood vessel vasculature while suppressing the background information. The following images (Figures 4–6) highlight the high sensitivity, vessel detail and high frame rate (~50 fps) of mSMI. SMI is able to detect blood vessels all the way out to the cortex in pediatric kidneys, even for patients as young as the 17-day-old infant shown in Figure 5. The detailed vessel branching observed with SMI is reminiscent of contrast-enhanced ultrasound images, but no intravenous contrast was needed.

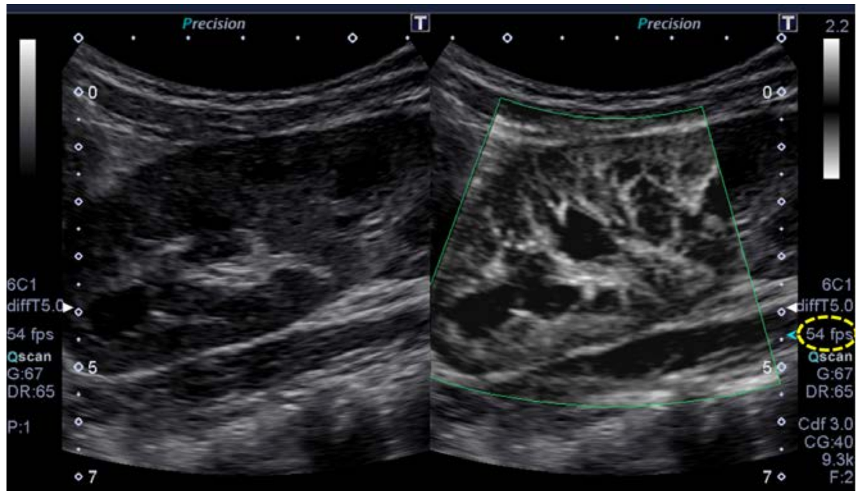

Figure 4. Side-by-side comparison of the B-mode image (left) and mSMI (right) from the kidney of a young patient. mSMI shows good visualization of small branching vessels that extend out to the cortex with a high frame rate of 54 fps.

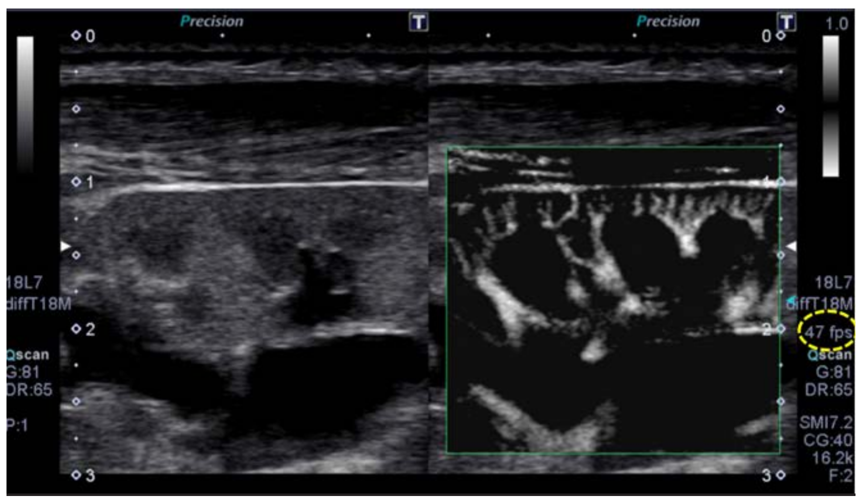

Figure 5. Side-by-side comparison of the B-mode image (left) and mSMI (right) from the kidney of a 17-day-old infant. mSMI shows good visualization of small branching vessels that extend out to the cortex with a high frame rate of 47 fps.

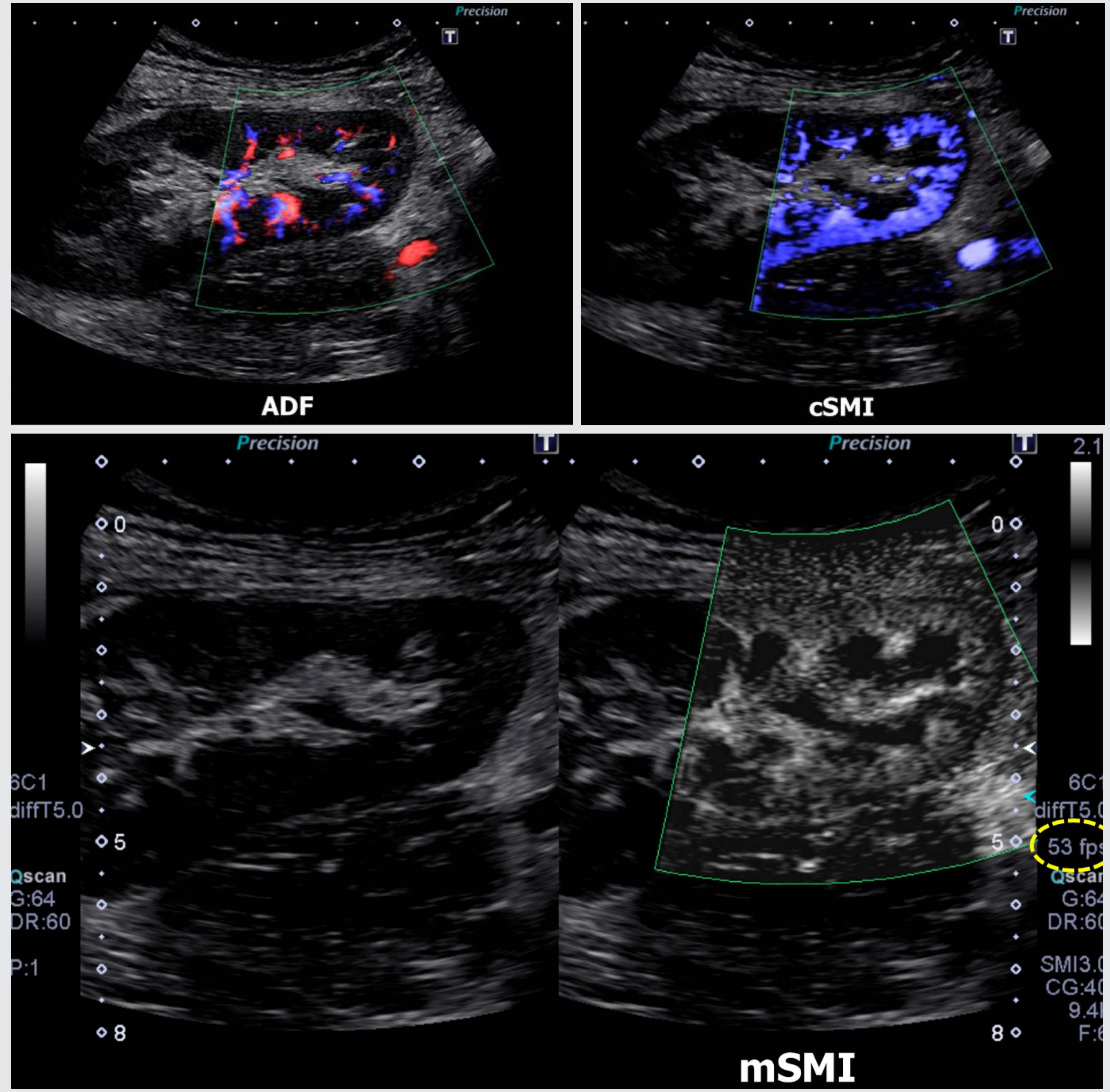

Figure 6. A comparison of Advanced Dynamic Flow™ (ADF, top), cSMI (middle), and mSMI (bottom) from a pediatric kidney in the same patient. SMI is able to detect vessels that extend out to the kidney cortex with high frame rates, as compared with ADF.

One specific clinical application where SMI may prove useful is for diagnosing vesicoureteral reflux in children presenting with urinary tract infections (UTI). The usual method of detecting vesicoureteral reflux from the bladder into the kidney is with X-ray cystography. Cystograms are frightening for children since bladder catheterization is invasive and sedation is generally not offered in order to see more physiologic voiding patterns.

Figure 7 shows an example of flow detected within the renal pelvis of a pediatric kidney using SMI. This case was a young patient being treated for a UTI. No anatomical anomalies were found to explain a predisposition to UTI, but SMI detected urinary flow in the renal pelvis toward the collecting system of the kidney, instead of toward the bladder. SMI provided a non-invasive and pain-free method for detecting vesicoureteral reflux in this patient. In addition, SMI offered a more rapid diagnosis and required no radiation exposure to the patient, as compared with cystography.

SMI saves time and increases diagnostic confidence. A 15-year-old male presented with scrotal pain and ultrasound imaging with SMI was performed to rule out testicular torsion (Figure 8). The small blood vessels detected on SMI can be verified by pulsed Doppler to confirm true flow for added confidence.

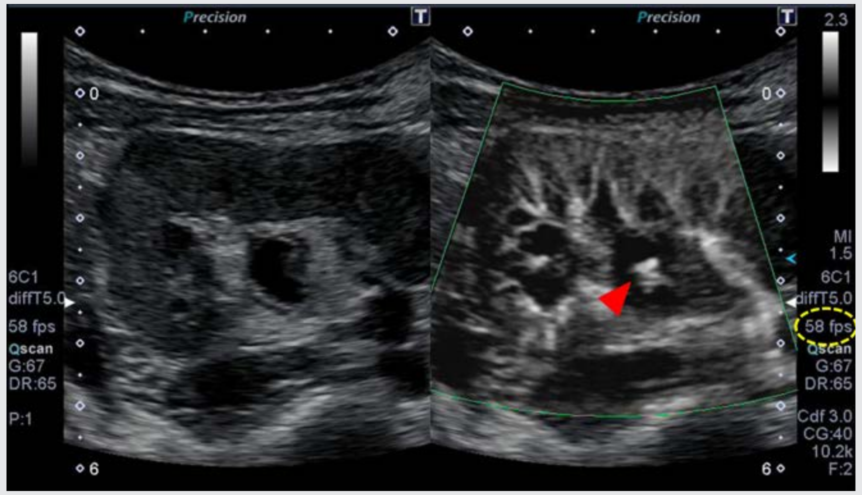

Figure 7. mSMI detection of urinary reflux (red arrow) in the renal pelvis of a pediatric patient being treated for urinary tract infection.

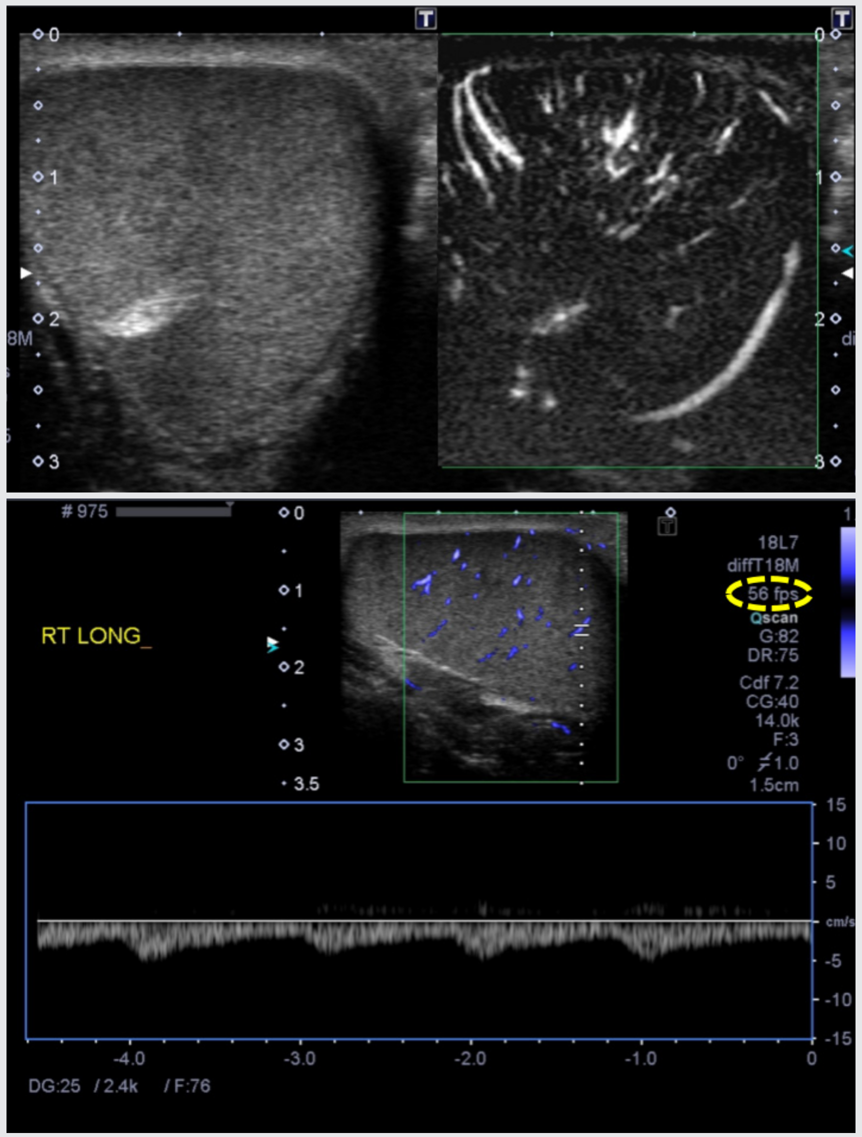

Figure 8. SMI of testicular blood flow in a 15-year-old patient presenting with scrotal pain. Pulsed Doppler can be used to confirm blood flow for added confidence.

SMI can help physicians to problem-solve and plan appropriate treatments. A suspicious lump in the neck was palpated by physicians in the Emergency Department. Even though some blood flow was detected by color Doppler, much more flow was observed on SMI, which more convincingly indicated that it would be inappropriate to attempt to drain this suspected abscess (Figure 9).

In summary, SMI is an exciting new Doppler technology, developed by Toshiba, providing clinicians with exquisite vascular detail quickly so they can focus on making a diagnosis. SMI improves the visualization of tiny vascular structures and thus aids diagnosis and treatment planning. It can save time and improve diagnostic confidence compared with existing techniques. SMI can rapidly confirm blood flow or detect the absence of flow in cases of torsion and ischemia. No intravenous contrast is needed with SMI, which is one reason that it is especially well suited for pediatric patients. Compared with conventional Doppler flow modes, SMI offers better detail resolution, faster frame rates, less clutter and fewer flash artifacts, potentially changing the way we work, replacing some uses of X-ray cystography and reducing unnecessary invasive procedures, such as aspirations and drainages.

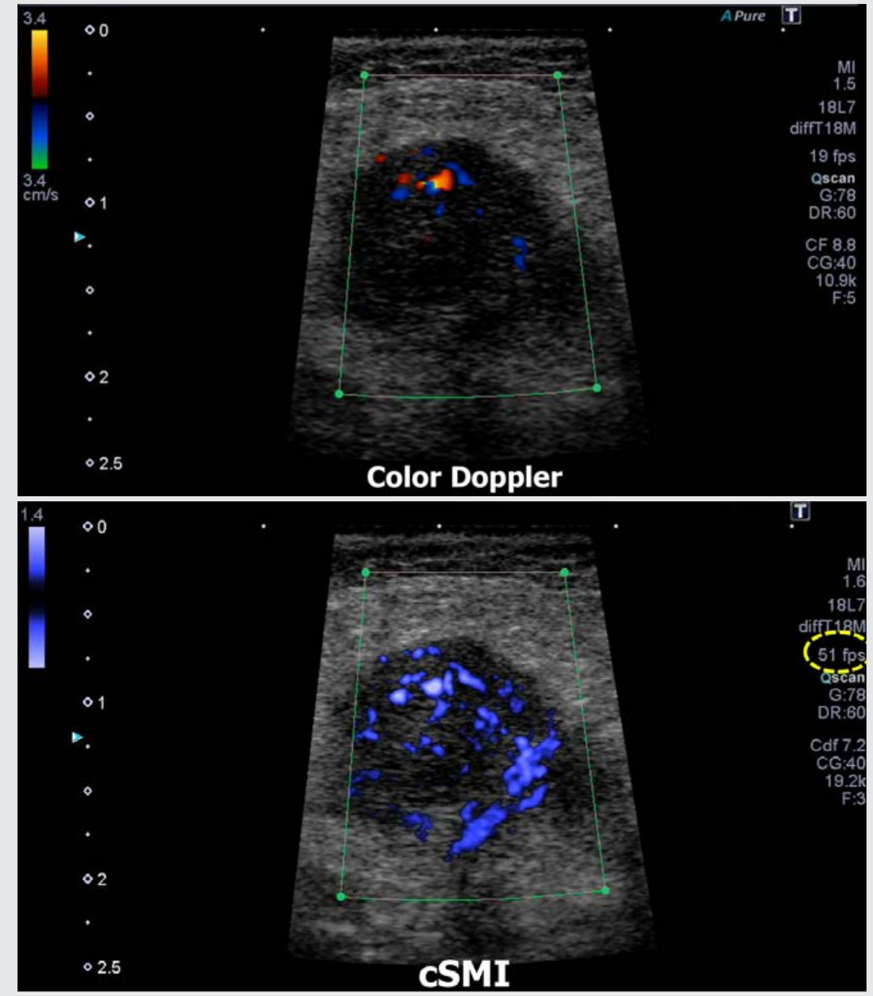

Figure 9. SMI (bottom) depicts more blood flow and better vessel detail than color Doppler (top) in this suspicious lump in the neck. SMI provides stronger evidence than color Doppler to not drain the suspected abscess.

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