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WHITE PAPER

MV-Flow™ in the Evaluation of Renal Masses

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Introduction

Incidental renal masses are commonly identified in routine ultrasound scanning. When focal renal lesions are identified, the most critical diagnostic questions to address are assessment of the nature and the potential clinical significance of these lesions. The majority of these are renal cysts with the biggest proportion being simple cysts requiring no active management. They may be seen in up to 50% of patients in the age group 70 years and above[1].

Current radiological evaluation of cysts uses the Bosniak criteria for classification. While the initial classification was based on CT[2] with modifications proposed and used[3,4] to further refine the classification, there is an increased use of ultrasound to characterize indeterminate and incompletely characterized cystic lesions identified on CT and MRI[5,6]. On ultrasound, the features evaluated in a cyst include presence of posterior acoustic enhancement, presence of debris, focal wall thickening including nodules, septations and their nature (number, regularity, and thickness) and the demonstration and characterization of vascularity and blood flow. There is an increased amount of interest in the use of CEUS (contrast enhanced ultrasound) to increase diagnostic confidence and further characterize these lesions. This is of importance especially in patients who cannot receive contrast enhanced CT or MRI due to logistics, expenses and medical reasons preventing their use.

For non-cystic or solid masses, ultrasound evaluation helps in characterization of the lesions into benign and malignant lesions. While differentiation may not be definitive, a combination of grayscale features, appearance on other available imaging modalities and an assessment of the vascularity are used to clinically characterize lesions. The clinical use of CEUS is evolving and increasing with a better understanding of its role and an acceptance in the medical community as knowledge of its strengths and applicability increases. In addition, the improved resolution and capabilities of modern Doppler technologies highly sensitive towards low velocity flow such as MV-Flow™ have improved the diagnostic potential of ultrasound in the characterization of renal mass lesions even without using CEUS[7,8].

MV-Flow™ technology

MV-Flow™ is a built-in, commercially available software installed on the high-resolution ultrasound system RS85 (SAMSUNG MEDISON, Co., Ltd., Seoul, Korea). It is an advanced power Doppler technique tool to detect microvascular flow that cannot be visualized on conventional Doppler images. In conventional color Doppler or power Doppler, it is often difficult to distinguish very low-velocity blood flow as it may be within the same velocity range as the background tissue, causing the ultrasound system to recognize the low-velocity blood flow as noise. However, MV-Flow™ offers a detailed view of low-velocity blood flow in relation to the surrounding tissues, with high sensitivity and resolution. It has a higher tissue suppression capability to reduce tissue noise. Its advanced filters provide enhanced sensitivity due to its advanced methodologies for compounding images. Eventually, unlike conventional Doppler, MV-Flow™ can detect microvascular (microfluidic channel) flow in tissues and organs.

As MV-Flow™ can identify the blood flow in areas in which it was previously undetectable, we anticipate that it will improve diagnostic reliability and potentially diagnostic confidence. Increased usage of this tool is expected to provide clinical benefits with a potential increase in the diagnostic accuracy and characterization of both cystic and solid renal masses even before or using CEUS.

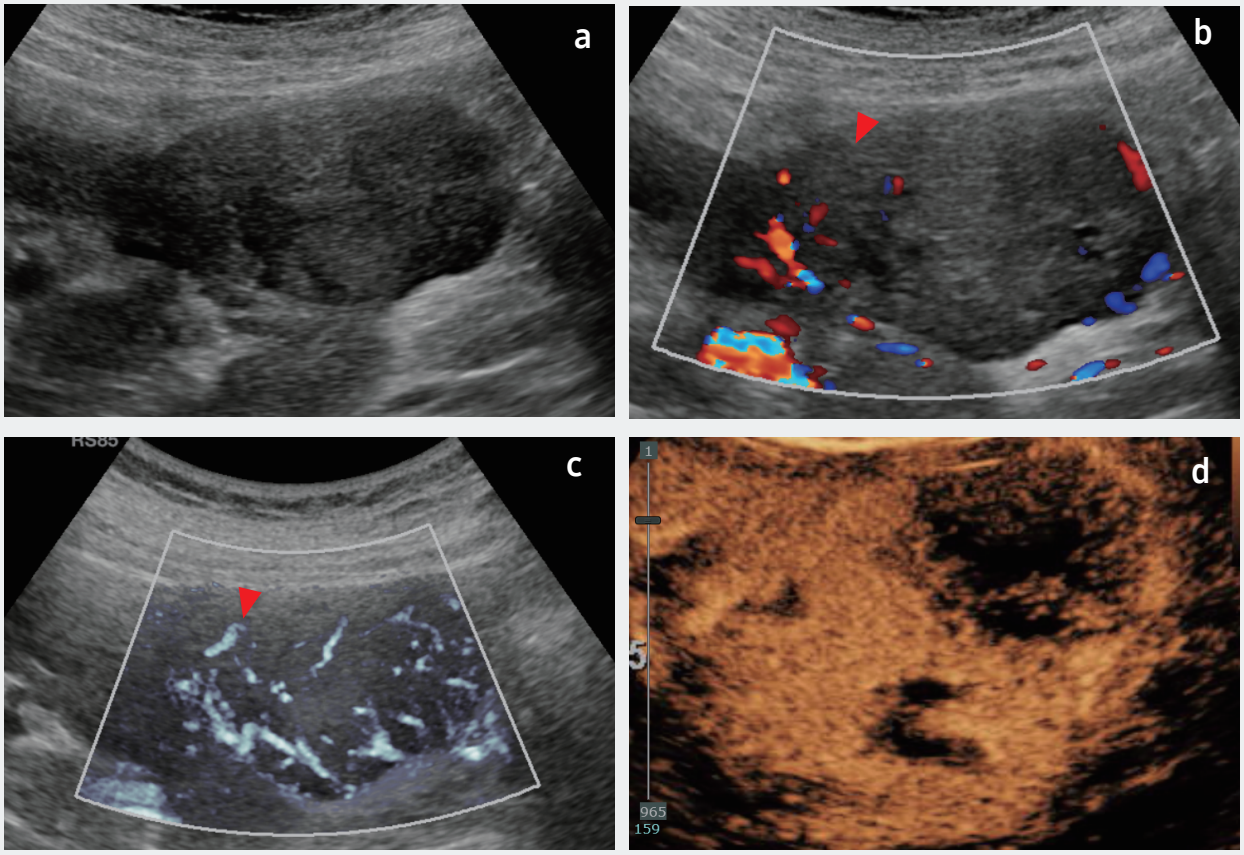
Methods

Patients referred for an evaluation of the kidneys at our institution underwent evaluation in multiple planes. Upon identification of focal lesions, additional focused imaging in at least two orthogonal planes was performed to characterize the lesion. Cine clips of sweeps through the kidneys in two planes were used to complement multiple static images. Subsequently, analysis using Doppler techniques including color Doppler, power Doppler and MV-Flow™ was performed. In specific cases, this was secondarily supplemented by CEUS.

Case examples

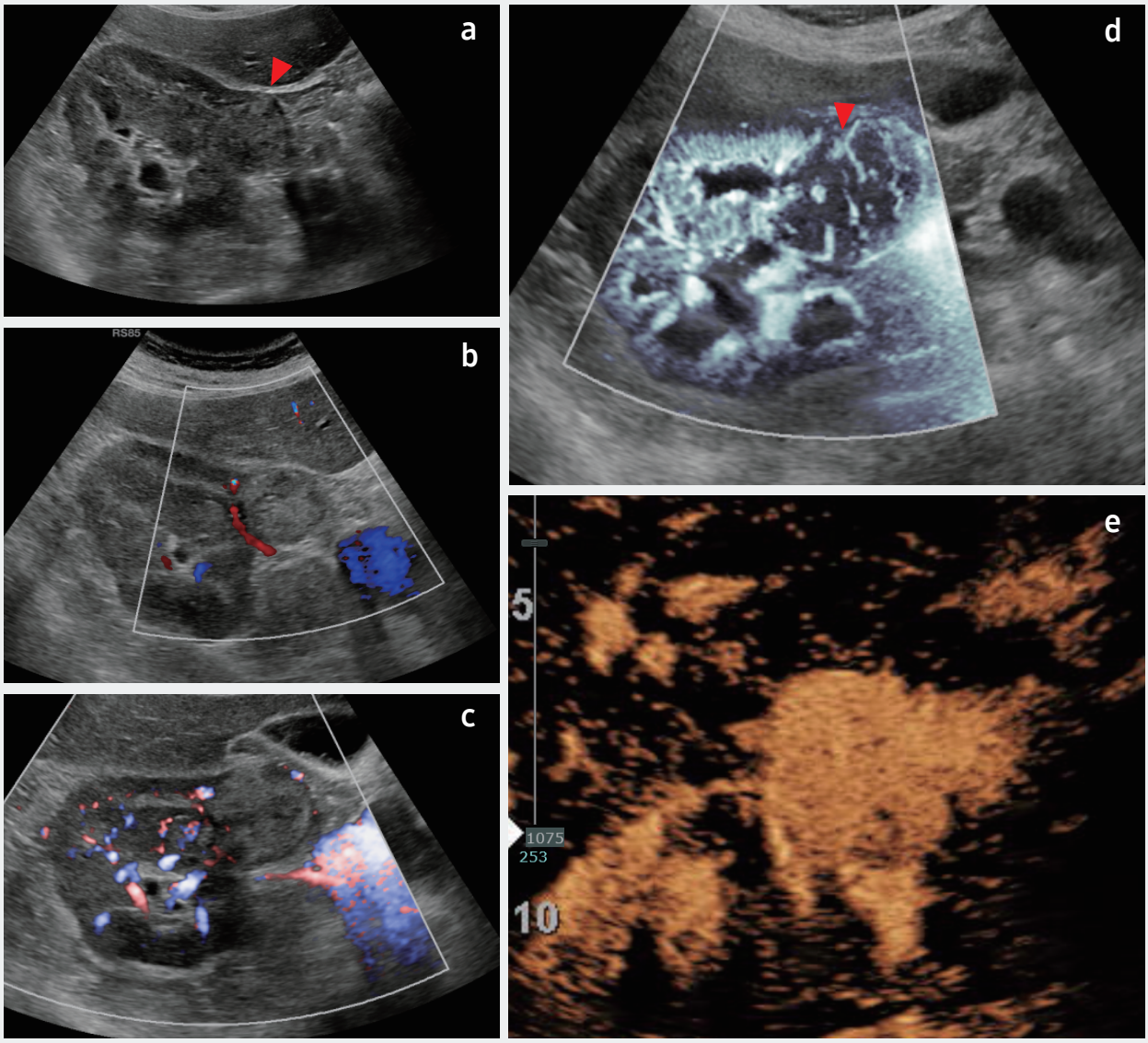
Below are images highlighting some interesting and illustrative renal mass cases comparing MV-Flow™ to color or power Doppler as well as with grayscale and CEUS.

Case 1 : A 76-year-old male patient presented with metastatic disease of unknown origin. An ultrasound study of the abdomen in the initial workup identified this slightly heterogenous exophytic lobulated mass in the right kidney. Color Doppler evaluation revealed only a small focus of flow in the mass, but MV-Flow™ demonstrated a larger amount of vascularized tissue throughout the mass confirming the presence of a neoplastic mass lesion. The final image using CEUS confirms the presence of vascularized tissue throughout the mass. This mass proved to be a clear cell renal cell carcinoma and had presented as a widely metastatic disease in this patient.



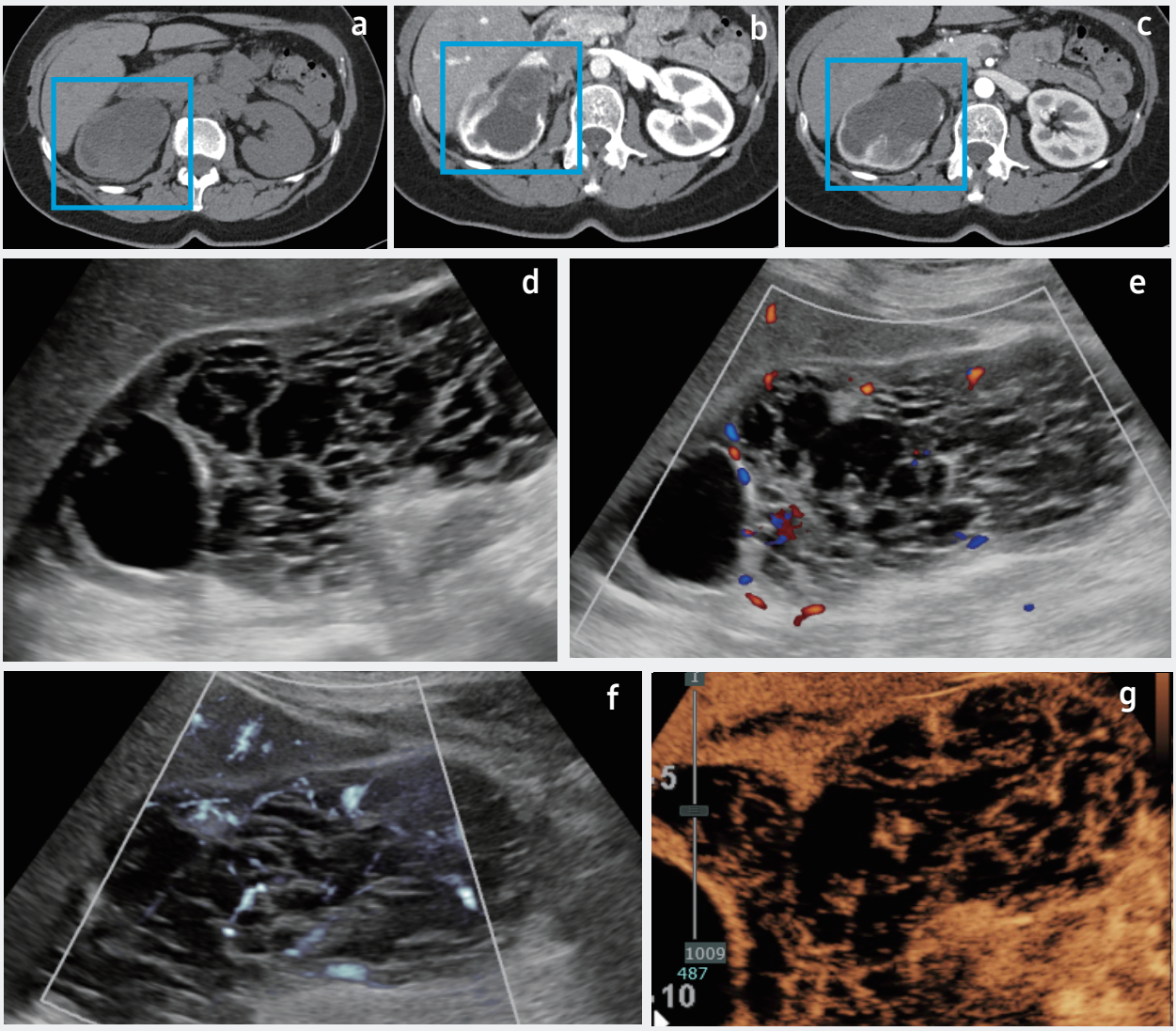
76-year-old male patient presented with metastatic disease. Grayscale (a), color Doppler (b), MV-Flow™ (c), and CEUS (d) images. A mass in the right kidney, subsequently proven to be a clear cell renal cell carcinoma. Note that while minimal flow is demonstrated on color Doppler imaging (arrowhead image b), low flow is identified on MV-Flow™ on image c, and subsequently confirmed with CEUS on image d.

Case 2 : An asymptomatic 64-year-old male patient was found to have an incidental renal mass in the right kidney. Note that while no intralesional flow is demonstrated on color Doppler imaging, low flow is identified on MV-Flow™, subsequently confirmed on CEUS. This mass on resection proved to be a case of renal cell carcinoma. The absence of flow on color Doppler imaging could have led to differentials of a complex hemorrhagic cyst or an avascular mass, but the demonstration of flow confirmed the presence of a neoplastic lesion.



Asymptomatic 64-year-old male patient. Grayscale (a), color Doppler (b), S-Flow™ directional power Doppler (c), MV-Flow™ (d), and CEUS (e) images of an incidentally identified mass (arrowhead image a) in the right kidney, subsequently proven to be a clear cell renal cell carcinoma. Note that while no flow is demonstrated on color Doppler imaging, low flow is identified on MV-Flow™ (image d), and subsequently confirmed on CEUS.

Case 3 : A 52-year-old female patient with a history of chronic renal failure, Chronic Kidney Disease Grade II, presented for evaluation of a mass-like lesion identified on Contrast-Enhanced Computed Tomography (CT). The CT scans demonstrate a multiloculated cystic mass, which extends into the renal pelvis and the proximal ureter with barely perceptible enhancement of septations. Grayscale ultrasound (US) revealed a complex cystic lesion with innumerable thickened septations, while color Doppler demonstrates minimal flow within some of the septations. MV-Flow™ demonstrates a larger number of the septations to have flow and CEUS confirms persistent and significant continuous enhancement of the multilocular septations. This mass proved to be a Mixed Epithelial Stromal Tumor (MEST).



- Contrast Enhanced Computed Tomography (fig. a-c) shows a multiloculated cystic mass, which extends into the renal pelvis and the proximal ureter.
- Grayscale ultrasound (d) shows a complex, cystic lesion, with innumerable thickened septations. Color Doppler (e) demonstrates minimal flow within the septations.
- MV-Flow™ (f) demonstrates more flow than color Doppler (e). CEUS(g) confirms persistent enhancement of the multilocular septations.

Conclusion

In conclusion, while grayscale US and Doppler techniques can help characterize a renal mass lesion, the addition of highly sensitive, advanced Doppler techniques such as MV-Flow™ can help increase the diagnostic accuracy and physician confidence by identifying the presence of low flow tissues. These low flow lesions or tissues are better characterized even without using additional contrast techniques. Our experience has shown that MV-Flow™ has the potential to enhance renal mass evaluation by improving sensitivity as well as diagnostic confidence without the need for potential contrast enhanced investigations.

System used – RS85
MV-Flow™ is available in the following systems
– HERA W10, HERA I10, HERA W9, RS85, RS80 EVO, V8, V7, HS60

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