Alternative Imaging in **chronic kidney disease**


Chronic Kidney Disease (CKD)

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Imaging in CKD

1. Identifying or confirming a specific disease entity (such as renal vascular or polycystic kidney disease) or treatable cause of failure (such as hydronephrosis)

2. Documenting renal size

3. Identifying renal position (for example, for biopsy)

4. Monitoring progression of disease

Ultrasound (US)

CKD diagnosis (but not definite diagnosis)

follow-up of its progression

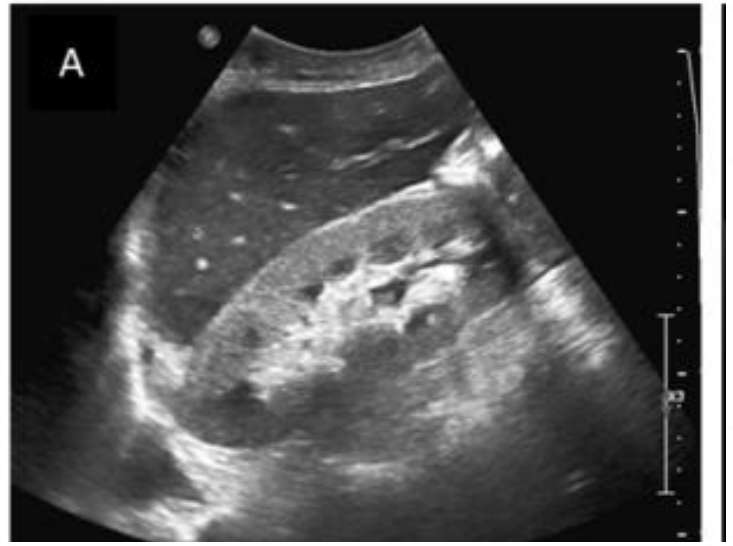
screen patients at risk for CKD

. Conventional US
. Doppler US

Conventional Ultrasound (US)

- ✓Measuring longitudinal diameter
- ✓Measuring cortical thickness
- ✓Evaluating renal echogenicity

- ✓Search for: masses or cysts, stones or urinary obstruction



Renal length

- ✓Maximum renal length is usually considered a morphological marker of CKD, as it decreases contemporarily to GFR.(1)

- ✓However, length has a low specificity in predicting renal impairment. Therefore, in clinical practice, serum Cr levels and calculated Cr clearance are more useful in predicting renal impairment.(2)

Renal echogenicity

- ✓The strongest association was observed with renal cortical echogenicity, echogenic kidneys indicate the presence of parenchymal renal disease (2,3)

Ultrasonographic CKD score

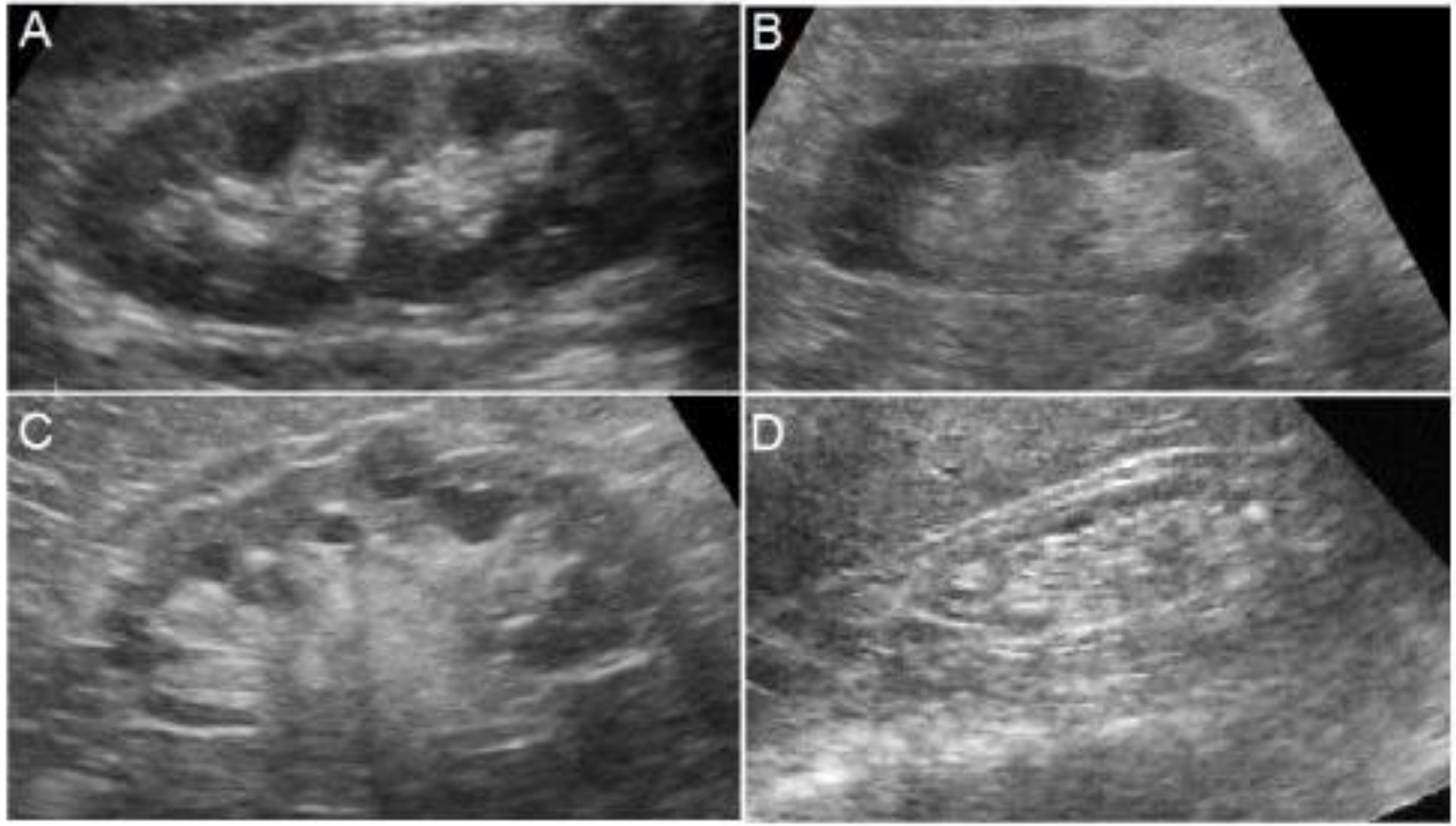
- ✓US parameters including kidney length, parenchymal thickness and parenchymal echogenicity were obtained from both kidneys. All 3 parameters were scored for each kidney, separately. The sum of the average scores of these parameters was used to calculate ultrasonographic CKD score.

- ✓GFR was negatively correlated with CKD score (4)

Search for etiology

- ✓During the progression of CKD (not end stage kidney), ultrasound imaging can differentiate the etiology of the renal damage in only 50–70% of cases.

- ✓ Indeed, the end-stage kidney appears shrunken, reduced in volume (Ø < 9 cm), unstructured, amorphous, and with acquired cystic degeneration (small and multiple cysts involving the cortex and medulla) or nephrocalcinosis(5)


A
B
C
D

Doppler US

1. Color Doppler :

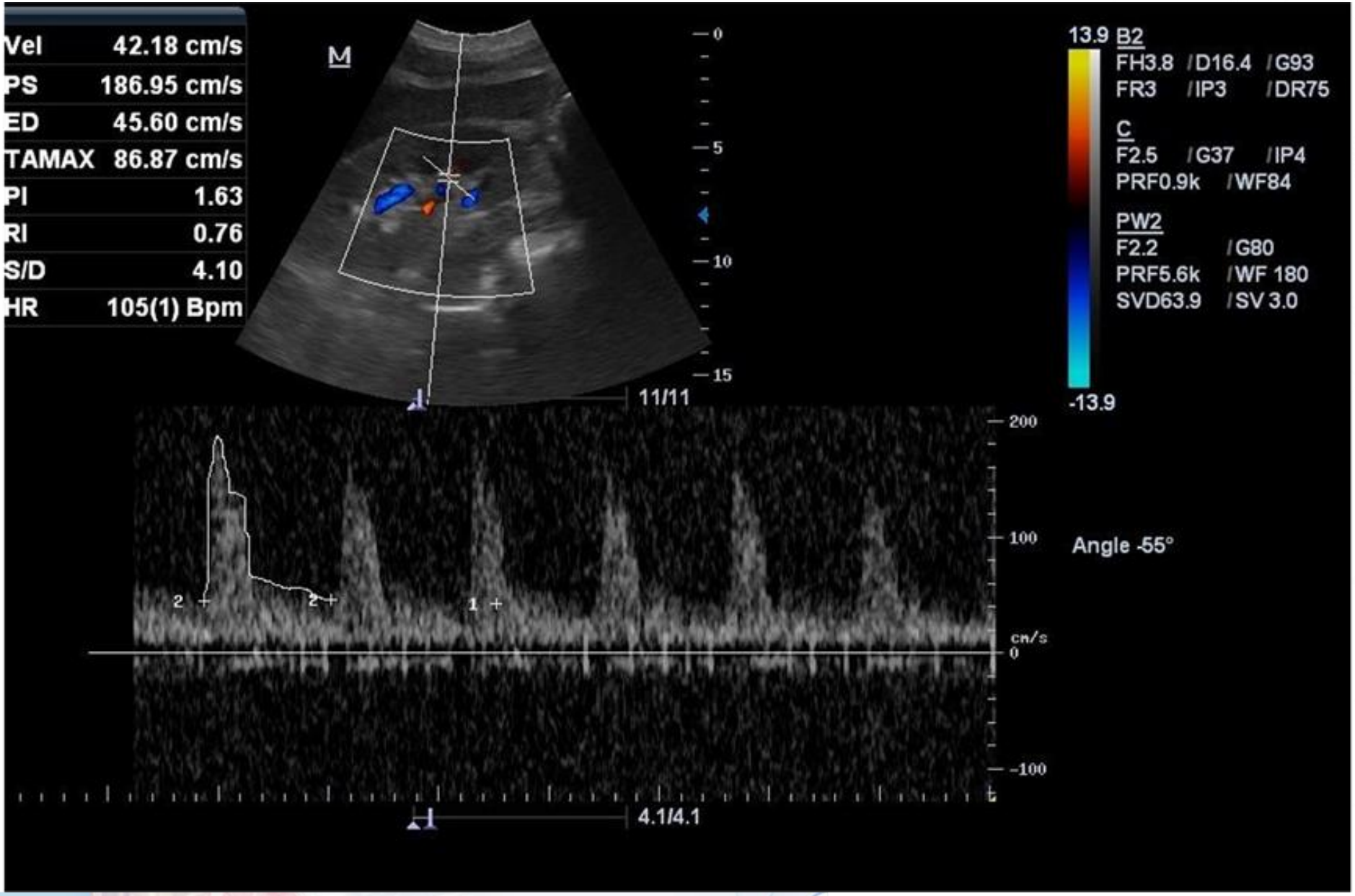
- parenchymal perfusion : the prevalence of perforating vessels differ between healthy subjects, patients with mild and with severe chronic renal failure. Only a few perforating veins is seen in patients with chronic renal failure.(6)
- patency of renal veins and arteries

2. Spectral Doppler:

- diagnosis of renal artery stenosis
- provides important information about intrarenal microcirculation

An RI of 0.70 or higher is predictive of an unfavorable outcome and the progression of CKD in patients with chronic nephropathies independent of initial eGFR. (1,7,8)

It significantly correlated with hemodynamic (blood pressure) and histopathological parameters (glomerular sclerosis, arteriolosclerosis, interstitial fibrosis/tubular atrophy, interstitial infiltration)(9)


Vel 42.18 cm/s
PS 186.95 cm/s
ED 45.60 cm/s
TAMAX 86.87 cm/s
PI 1.63
RI 0.76
S/D 4.10
HR 105(1) Bpm
M
0
5
10
15
11/11
13.9 B2
FH3.8 /D16.4 /G93
FR3 /IP3 /DR75
C
F2.5 /G37 /IP4
PRF0.9k /WF84
PW2
F2.2 /G80
PRF5.6k /WF 180
SVD63.9 /SV 3.0
-13.9
200
100
cm/s
0
-100
Angle -55°
2
2
1
4.1/4.1

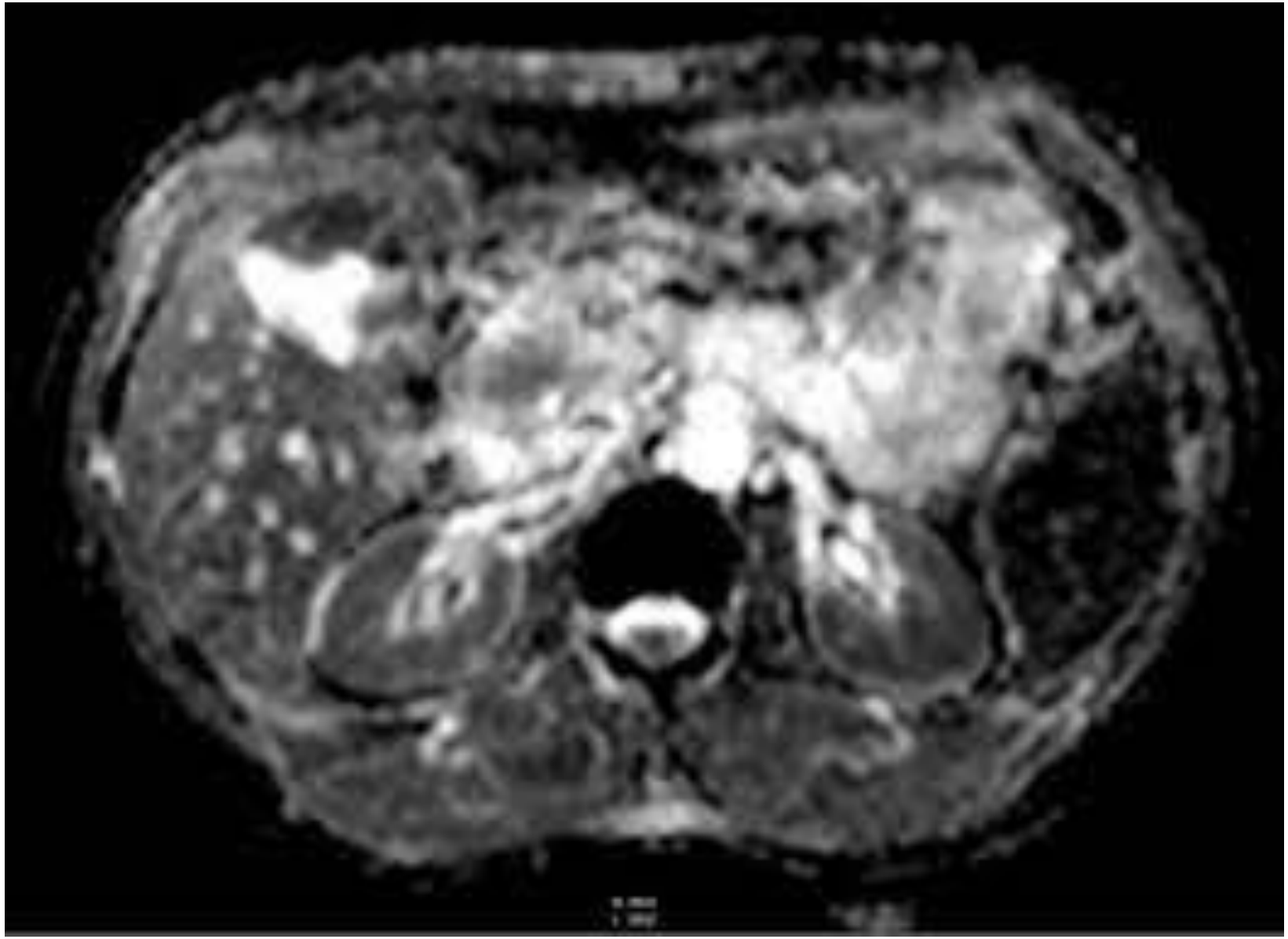
MR imaging (MRI)

- ✓Identify a wide range of anatomical and physiological parameters such as tissue perfusion, oxygenation, water diffusion, cellular phagocytic activity, tissue stiffness, and level of renal filtration. (10)

ADC value

- ✓Patients with CKD have significantly lower renal ADC than healthy individuals. The ADC values of kidneys is significantly lower than normal at most stages of CKD, except CKD1. There is a negative correlation between the ADCs and serum creatinine level amongst the patients(11,12)

- ✓Low ADC can be a predictor of kidney function decline and dialysis initiation in patients with native kidney disease or kidney allograft, independent of baseline kidney function.(13)



CT scan

- ✓CT is also able to combine morphological and functional information, but the use of CT is limited due to the required exposure to X-ray irradiation and a risk of contrast-induced nephropathy following intravenous injection of a radio-contrast agent.

The use of contrast in patients with CKD

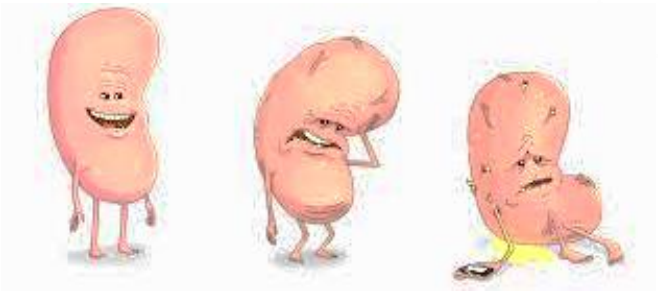
- ✓Consideration should be given to imaging techniques that may offer the same diagnostic information without the need to administer iodinated or Gd contrast agents.
- ✓The contrast administration has to be deemed essential for the patient's management, and the potential risk must be weighed against the benefits.
- ✓Reduce the risk of CIN/NSF as much as possible

CT scan or MRI with contrast?

- ✓. The prevalence of CIN in patients with low GFR is up to30% to 40% . On the other hand, NSF occurs mainly in patients with advanced reduction in renal function (GFR <30 mL/min), with an incidence of <5%.
- ✓In addition, all iodinated contrast agents have the potential to induce CIN, whereas NSF can possibly be prevented by using the lowest possible dose of a macrocyclic Gd contrast and avoiding repeat contrast administration.

CT scan or MRI with contrast?

- ✓ The chance of inducing CIN is much higher than of inducing NSF in patients suffering from renal impairment so it seems that contrastenhanced MRI is more appropriate than contrastenhanced CT scan in patients with renal impairment.



How to reduce the risk of CIN?

Patients with renal impairment in whom the administration of contrast is deemed necessary should receive the :

- lowest possible dose of isosmolar or lowosmolar nonionic contrast
- Hydration (100 mL/hour) for at least 4 hours before and after contrast injection
- The effectiveness of the prophylactic use of nephroprotective drugs such as acetylcysteines remains uncertain

How can the risk of NSF be reduced?

- ✓The lowest possible dose of stable Gd contrast agents (macrocyclic chelates) instead nonionic linear chelates should be used in these patients such as gadobenate dimeglumine or gadobutrol.
- ✓Patients on hemodialysis can be scheduled to have the dialysis session shortly after the MRI examination to reduce the Gd contrast load

Administration of contrast to patients on hemodialysis

- ✓Patients undergoing hemodialysis should undergo dialysis shortly after contrastenhanced MRI to reduce the Gd contrast load.
- ✓In contrast, CIN is irrelevant in hemodialysis patients, as the kidneys are already extensively damaged with no important residual renal function to protection.

Administration of contrast to patients on peritoneal dialysis

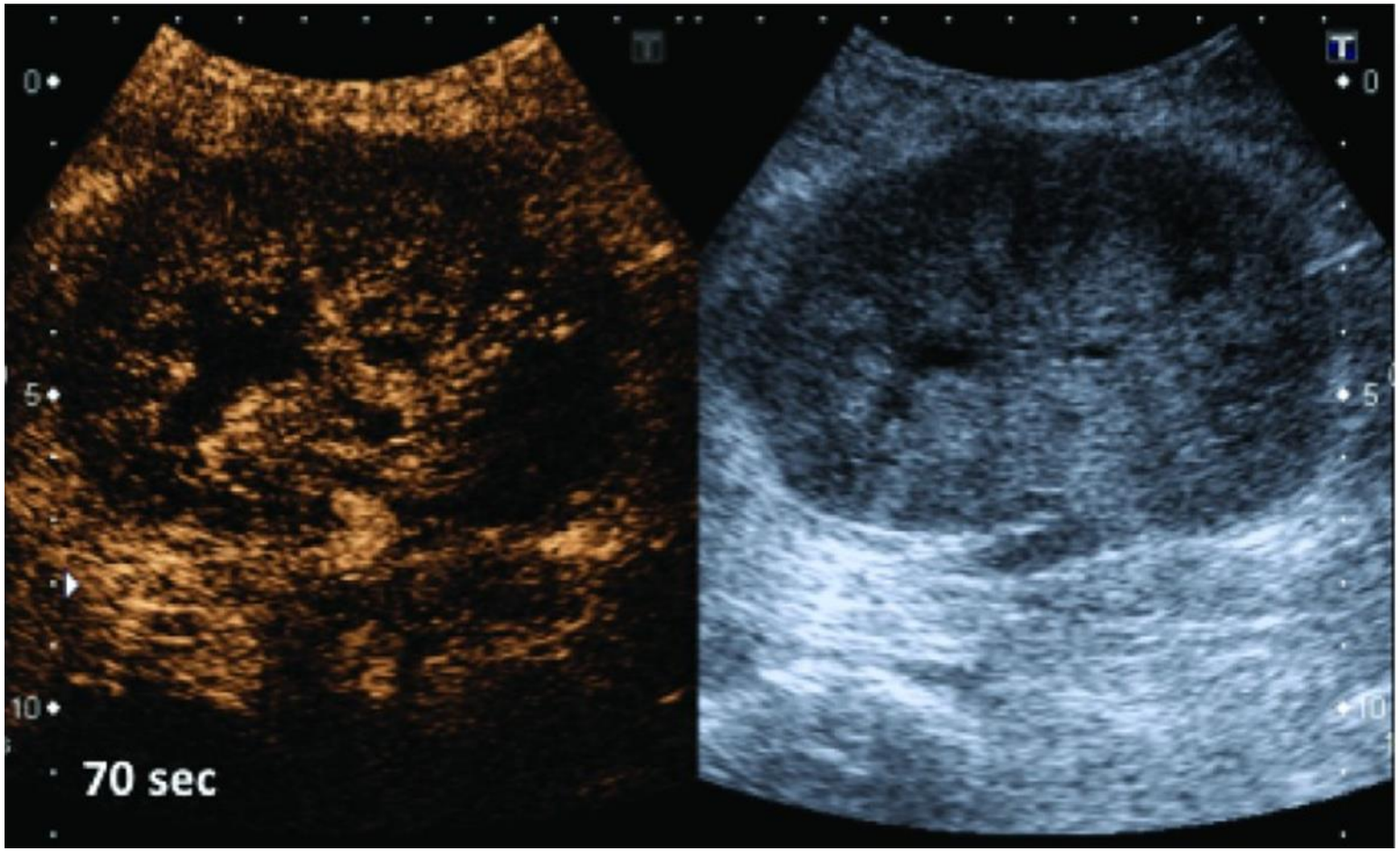
- ✓These patients are particularly at extra risk and require careful assessment and wise judgment in considering the use of contrast agents. Protecting residual renal function is clinically important, and therefore, CIN is better avoided.
- ✓They are at increased risk of NSF because the prolonged half-life of Gd contrast. (14)

New methods(15,16)

- ✓CEUS (Contrast-enhanced ultrasound)
- ✓ Elastography
- ✓Arterial spin labeling (ASL) MRI
- ✓ Blood oxygen level-dependent (BOLD) MRI
- ✓ Dynamic contrast-enhanced (DCE) MRI
- ✓ Artificial Neural Network

Contrast-enhanced ultrasound

measuring kidney perfusion



thanks