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Hydronephrosis - is this always obstruction?

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BMUS General Medical Study Day

26 June 2026

Disclosure

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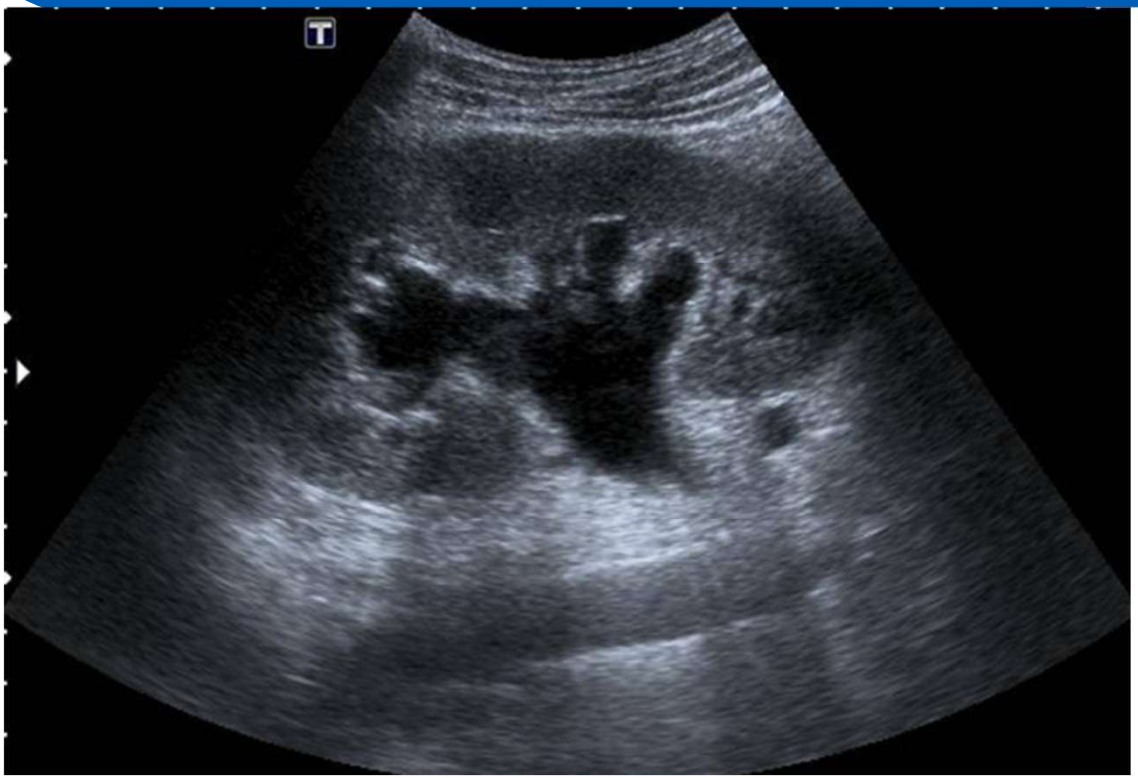
- The content and views presented are made available for educational purposes only. The information & data presented are the opinions of the presenter and do not necessarily represent the views of Hull University Teaching Hospitals (HUTH) / Humber Health partnership (HHP), or Canon Medical Systems

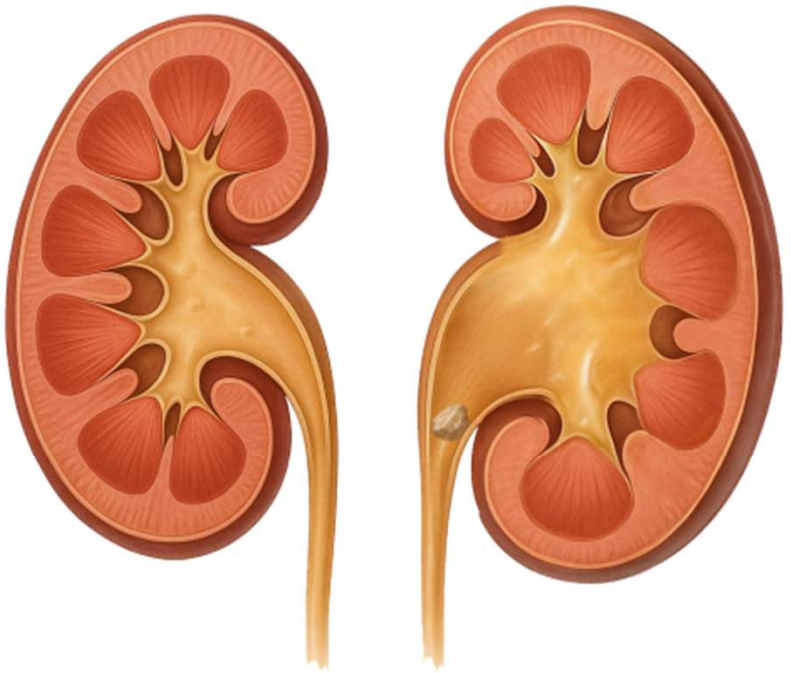
- *Not all images are of the cases I describe – some artistic licence has been used*

Aim & objectives

- What do we mean by hydronephrosis?
- How do we assess?
- Review AKI and the role of US
- Taking US one step further

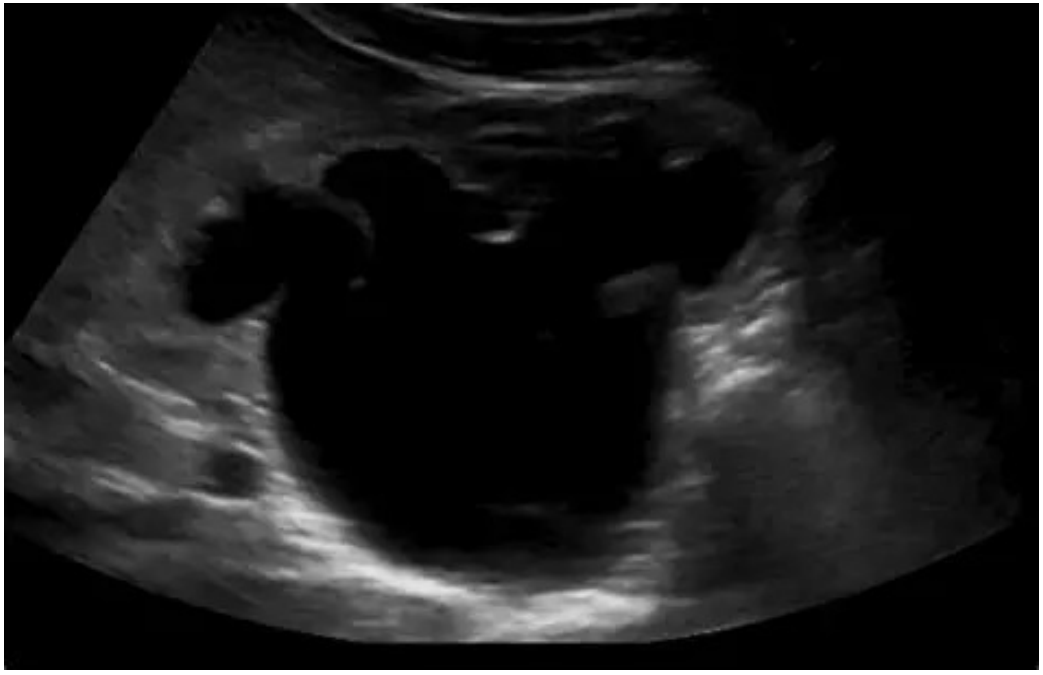
Hydronephrosis

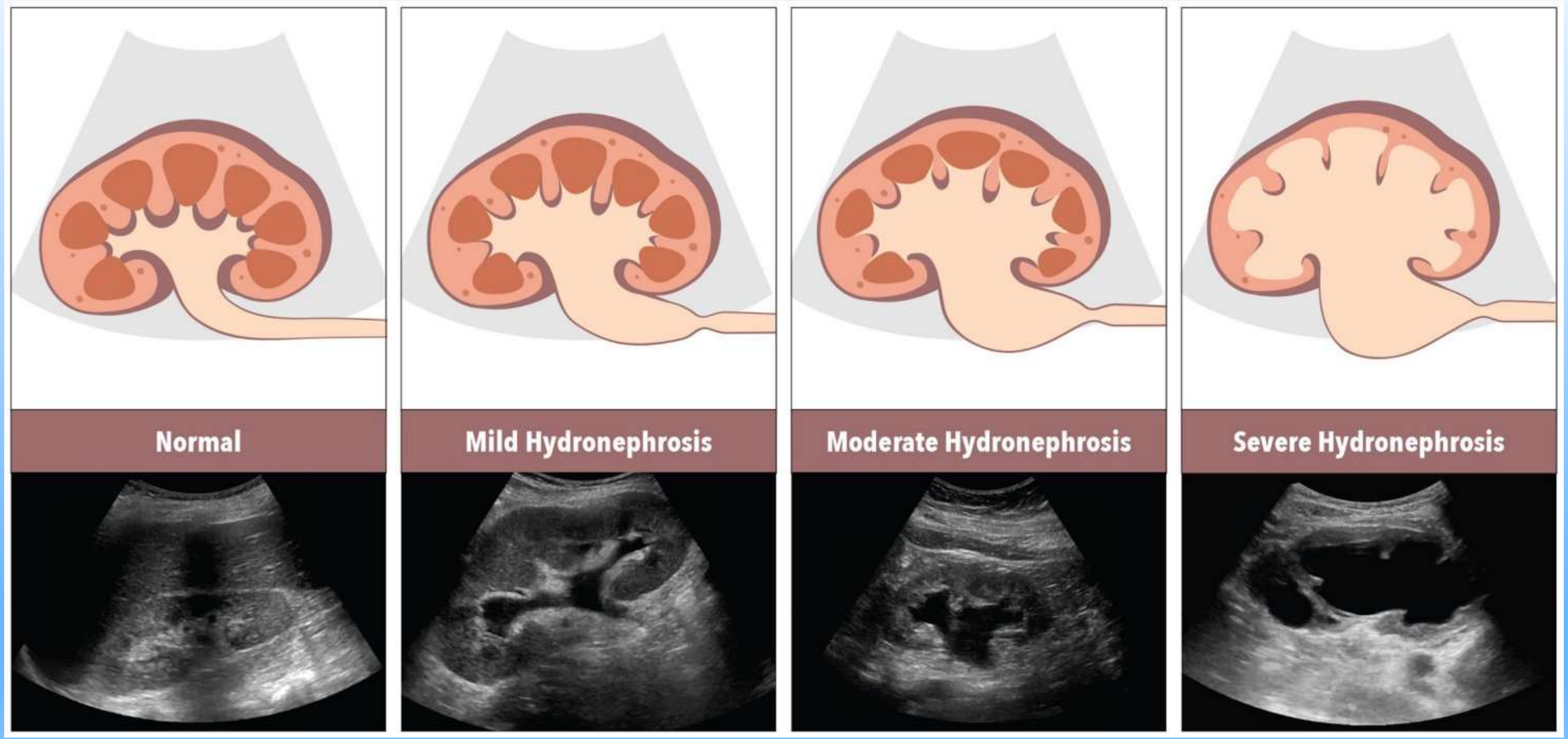




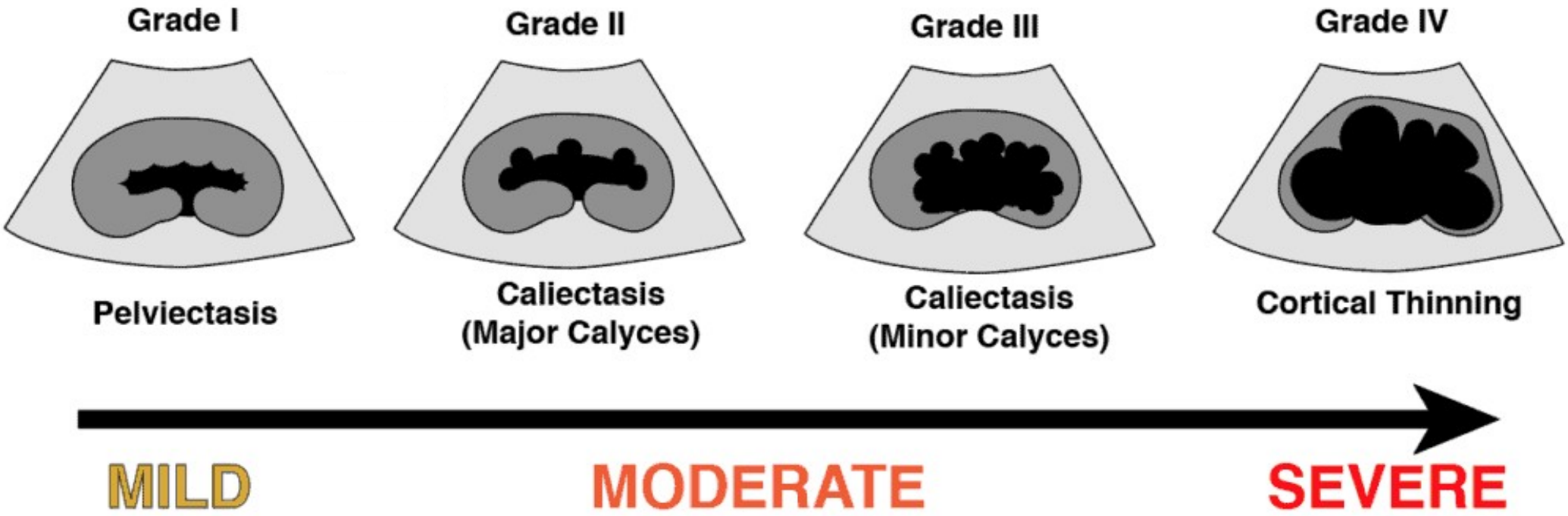
Hydronephrosis

- Dilation of renal collecting (pelvicalyceal) system ± ureteric dilation from an intrinsic or extrinsic cause
- Acute: oedema & pain
- Chronic: Loss of renal parenchyma and function



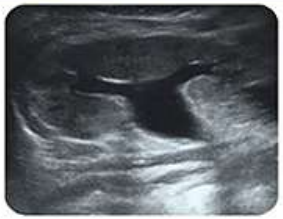
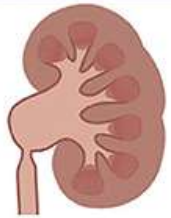

Normal
Mild Hydronephrosis
Moderate Hydronephrosis
Severe Hydronephrosis

Renal Ultrasound Hydronephrosis Grading

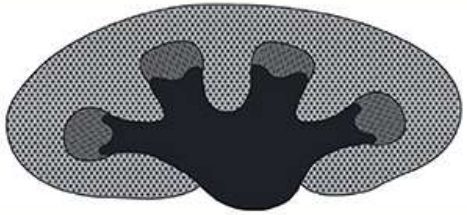
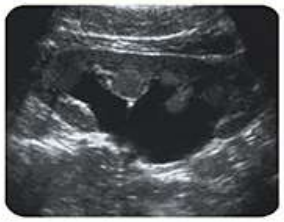


Onen Hydronephrosis Grading System

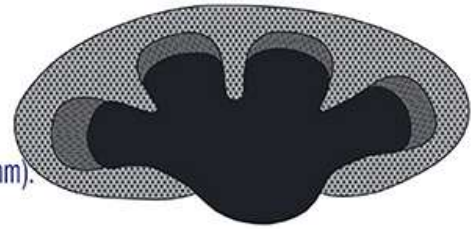
Grade-1:
- Renal **pelvic dilation** alone.
- AP diameter is not important.

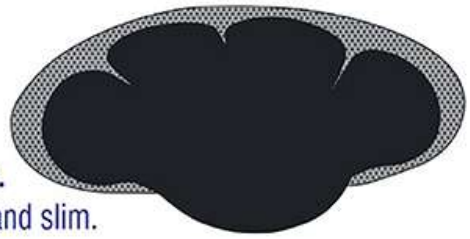
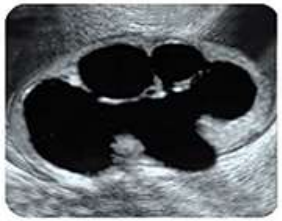
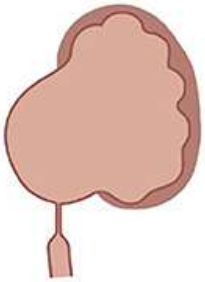
Grade-2:
- Pelvis + **Caliceal dilation.**
- Renal parenchyme (Medulla and Cortex) are normal (>7 mm).
- AP diameter is not important.

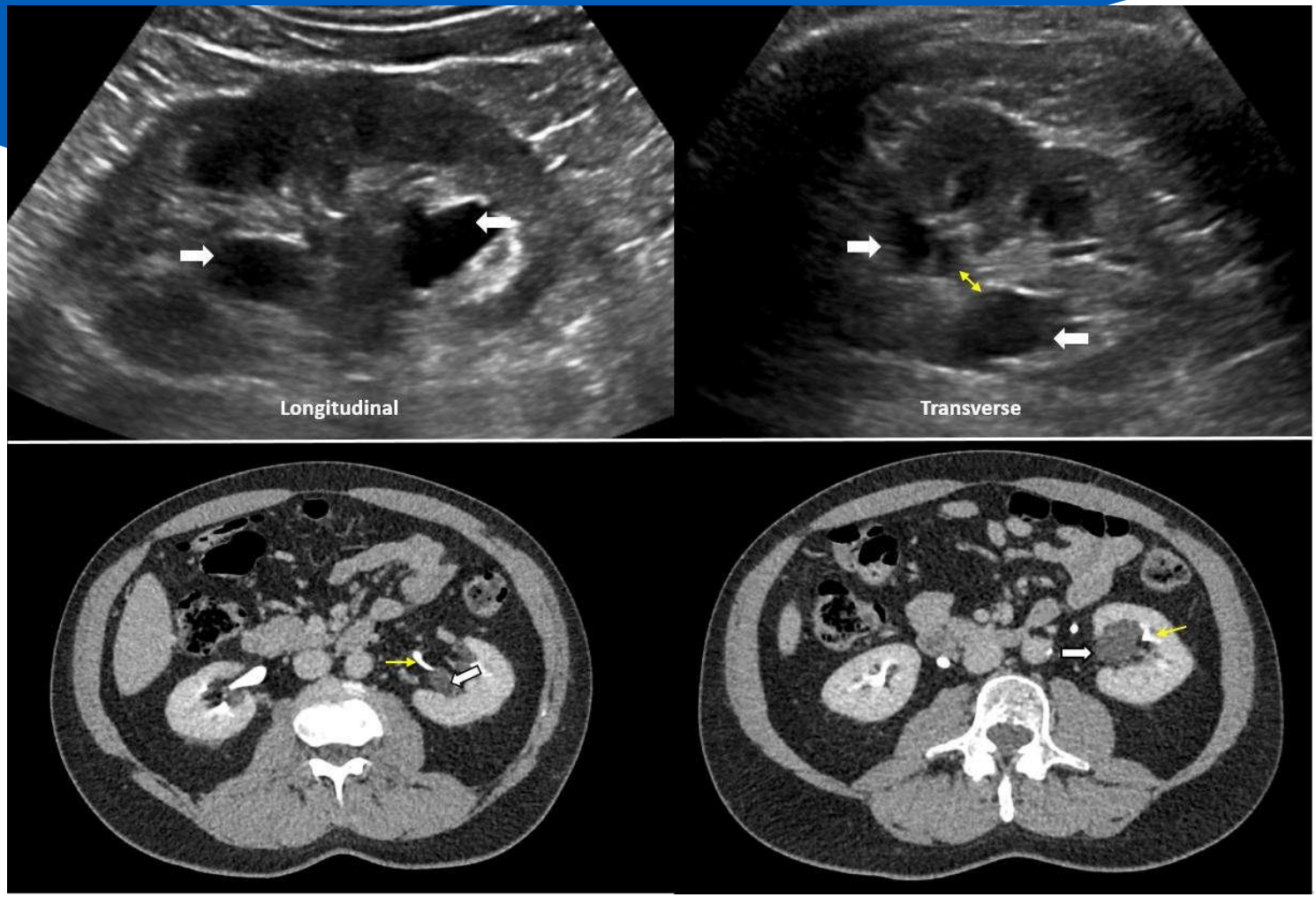

Grade-3:
- Pelvis + Caliceal dilation.
- **Medulla is short and thin.**
- Cortex is normal.
- Total parenchymal thickness: (PK:2.trimester 2-5mm, 3.trimseter 2.5-6mm, postnatal3-7mm).
- Corticomedullary differentiation is normal.
- AP diameter is not important.

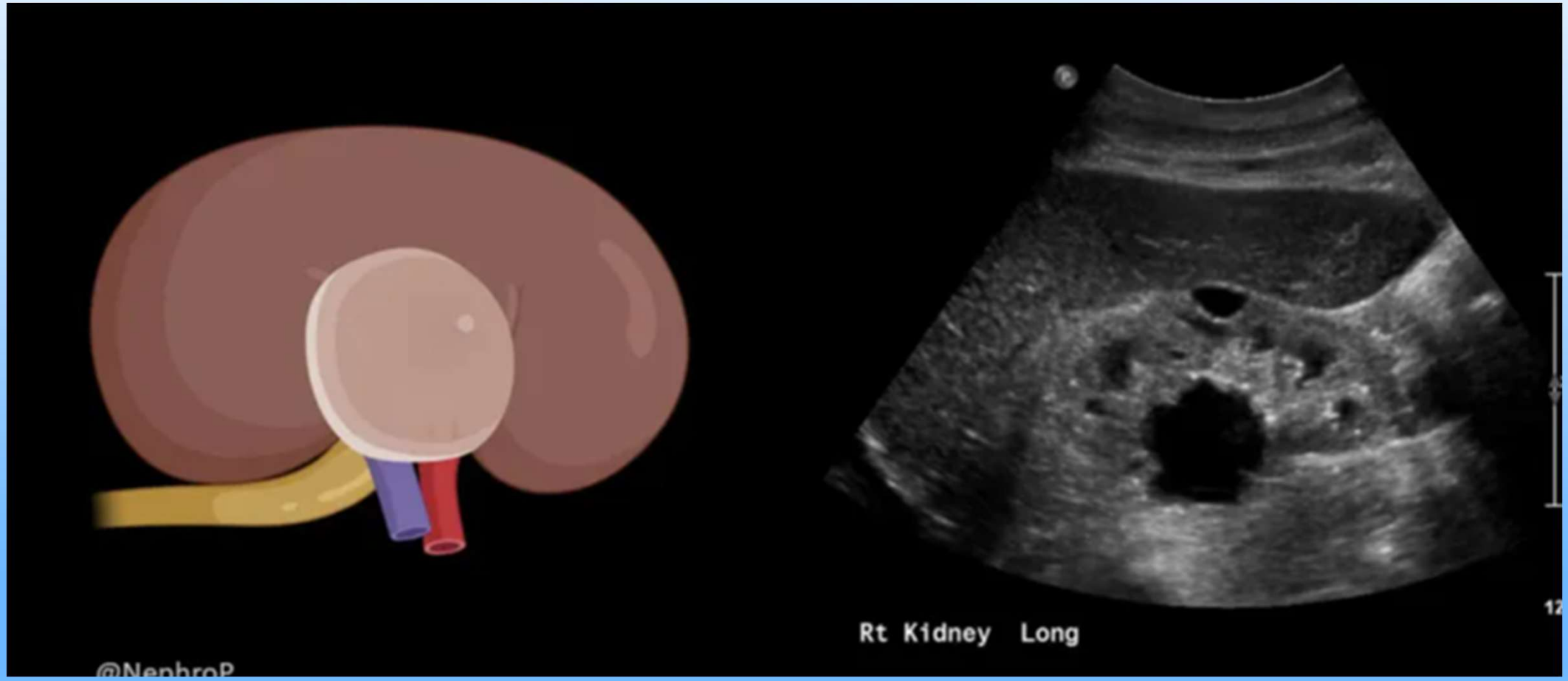


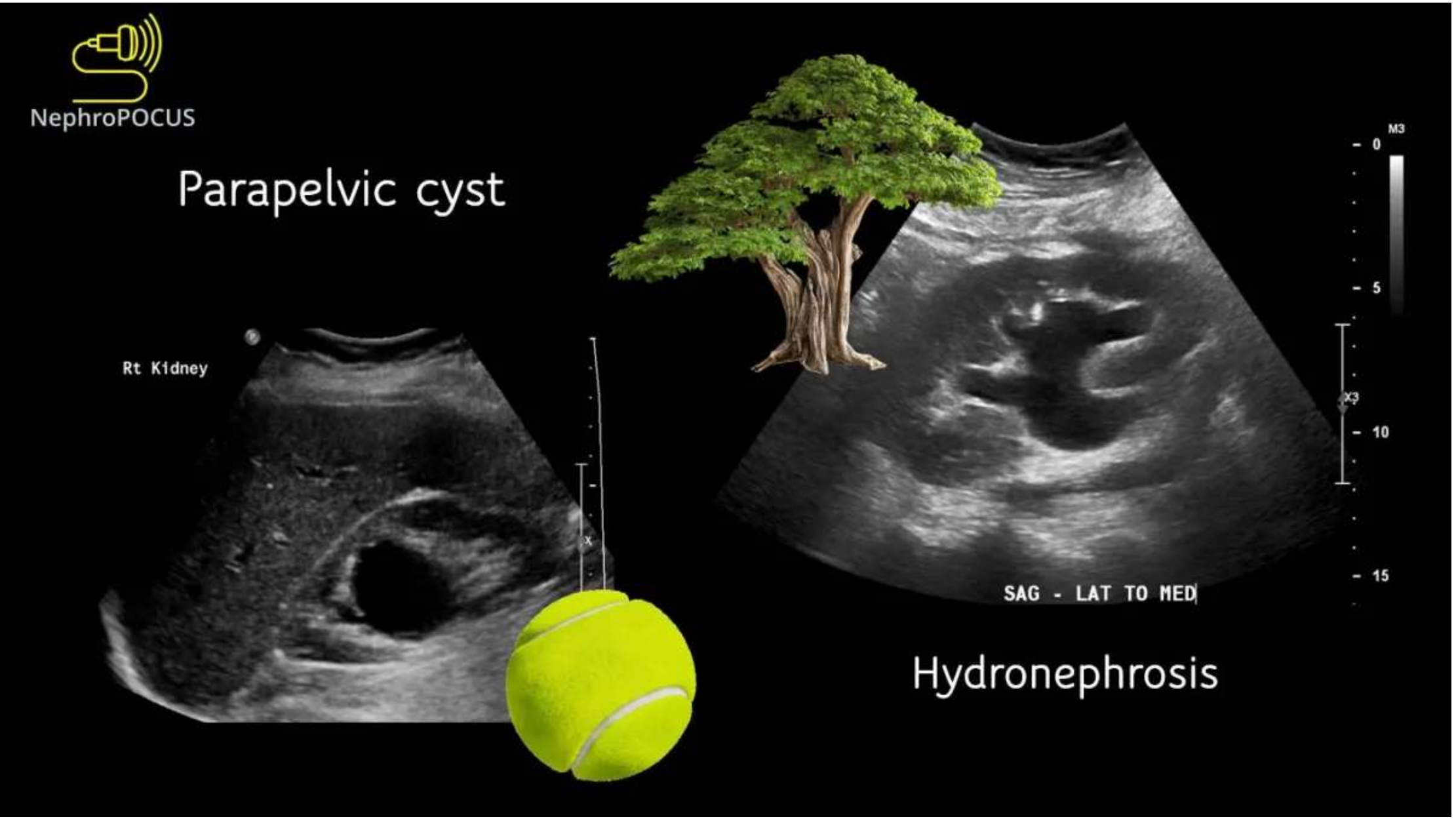
Grade-4:
- Pelvis + Caliceal dilation.
- There is no medulla (total loss).
- **Cortex is thin** (Second trimester <2mm, third trimester <2.5mm, Postnatal <3 mm).
- **There is no corticomedullary differentiation.**
- Recesses between calyxes significantly short and slim.
- AP diameter is not important.

Mimics of hydronephrosis



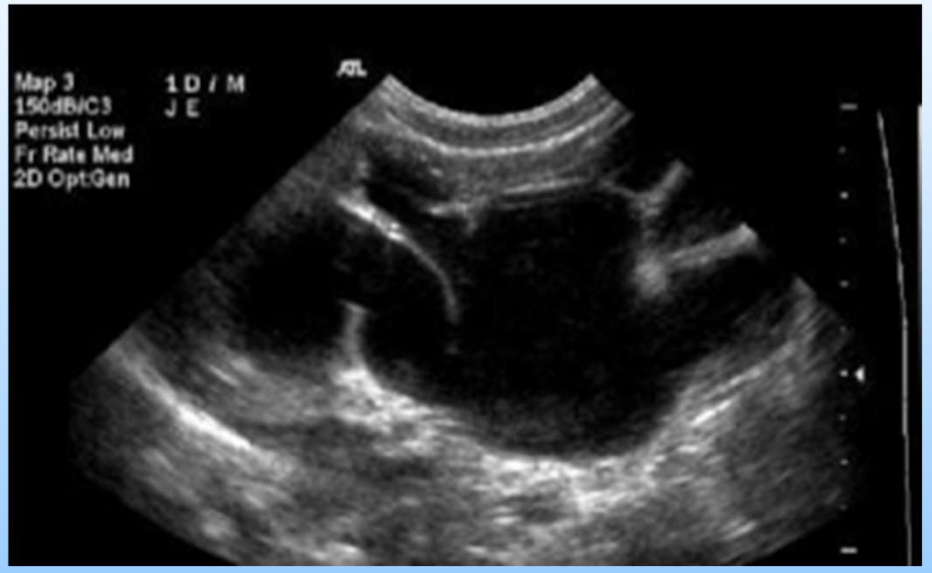

@NephroP
Rt Kidney Long


NephroPOCUS
Parapelvic cyst
Rt Kidney
SAG - LAT TO MED
Hydronephrosis

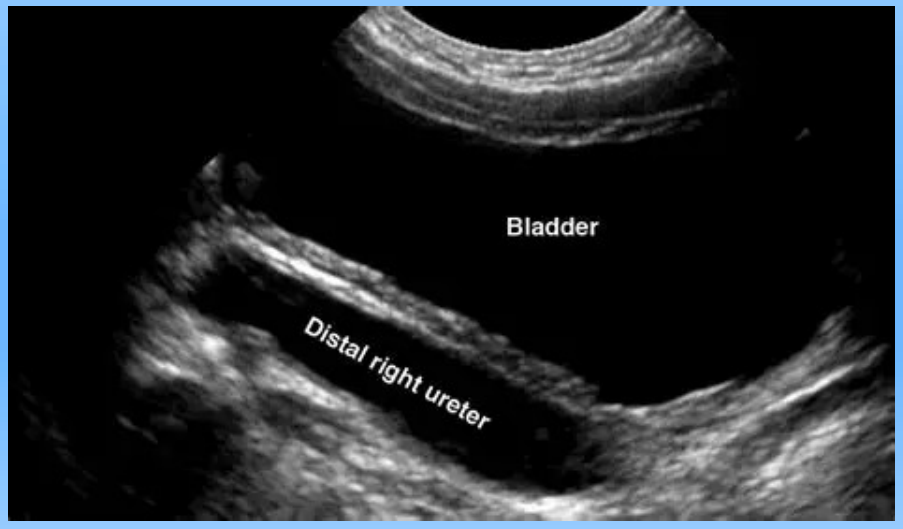
Causes of hydronephrosis

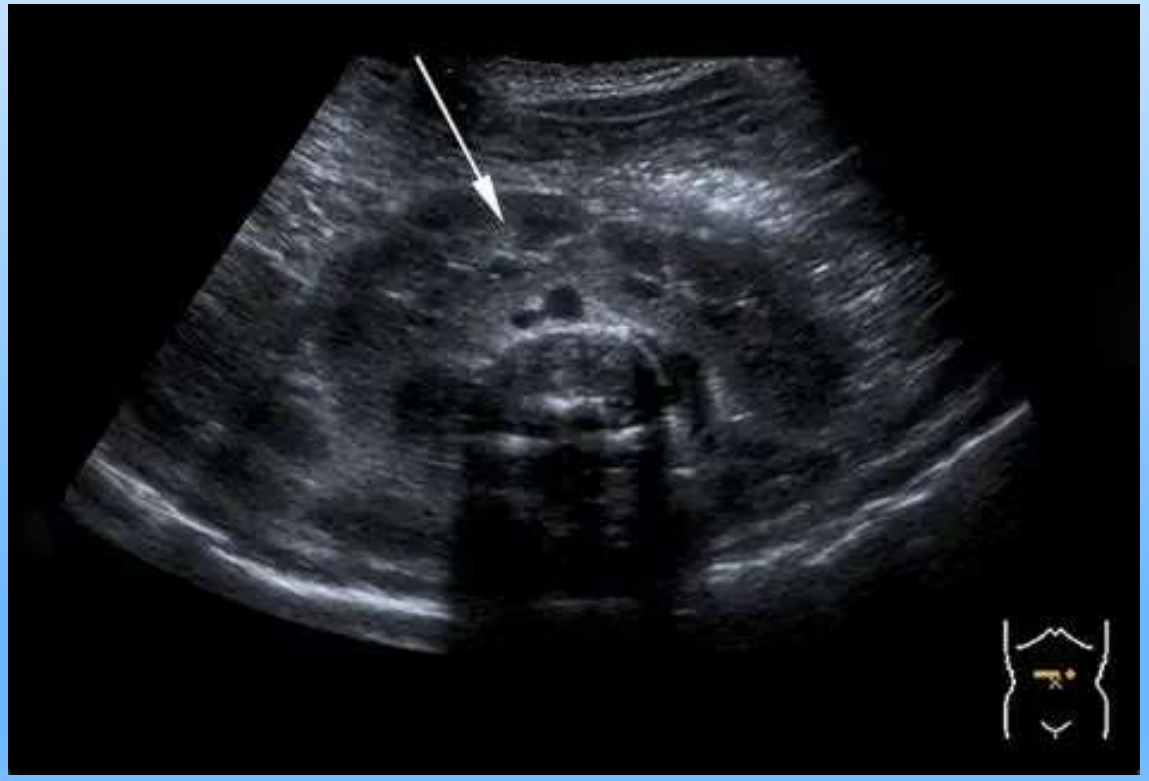
	Intrinsic	Extrinsic
Congenital	Urethral Valve	Dysmorphic (horseshoe / fused)
	Ureterocele	Duplex
	Polycystic kidney	RA Aneurysm
	Tumour	Compressive tumour
Acquired	Stone	Compressive tumour
	Tumour (TCC/ RCC)	Benign prostatic hyperplasia
	Urethral stricture	Trauma
	Inflammation / infection	Scoliosis

Congenital: intrinsic and extrinsic



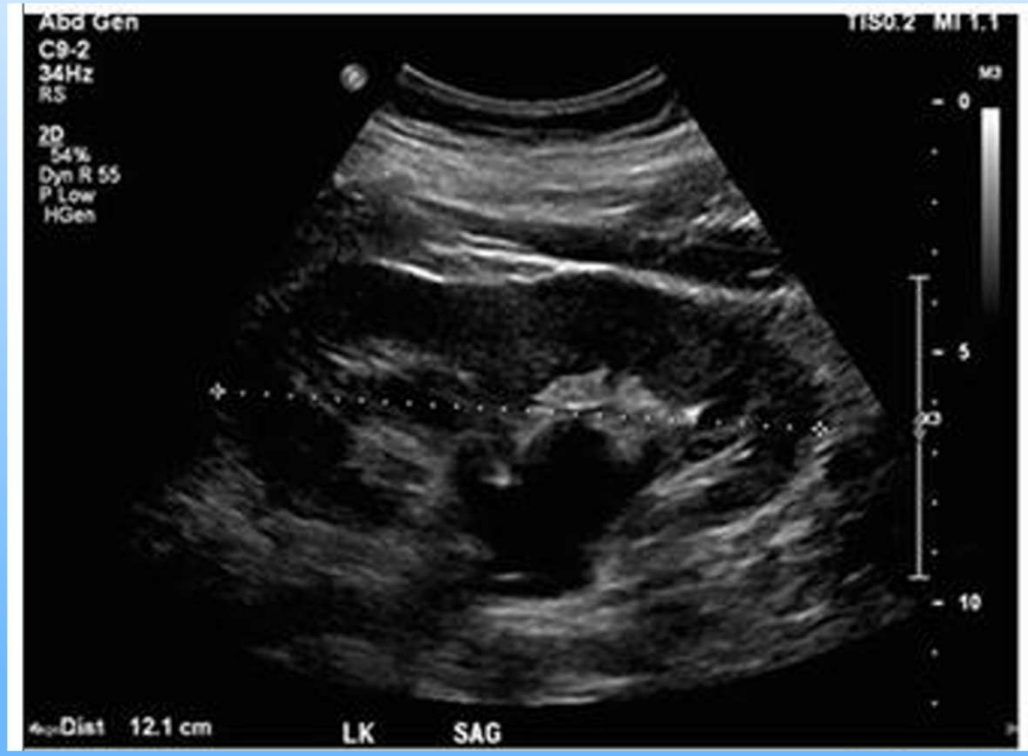
Urethral valve obstruction

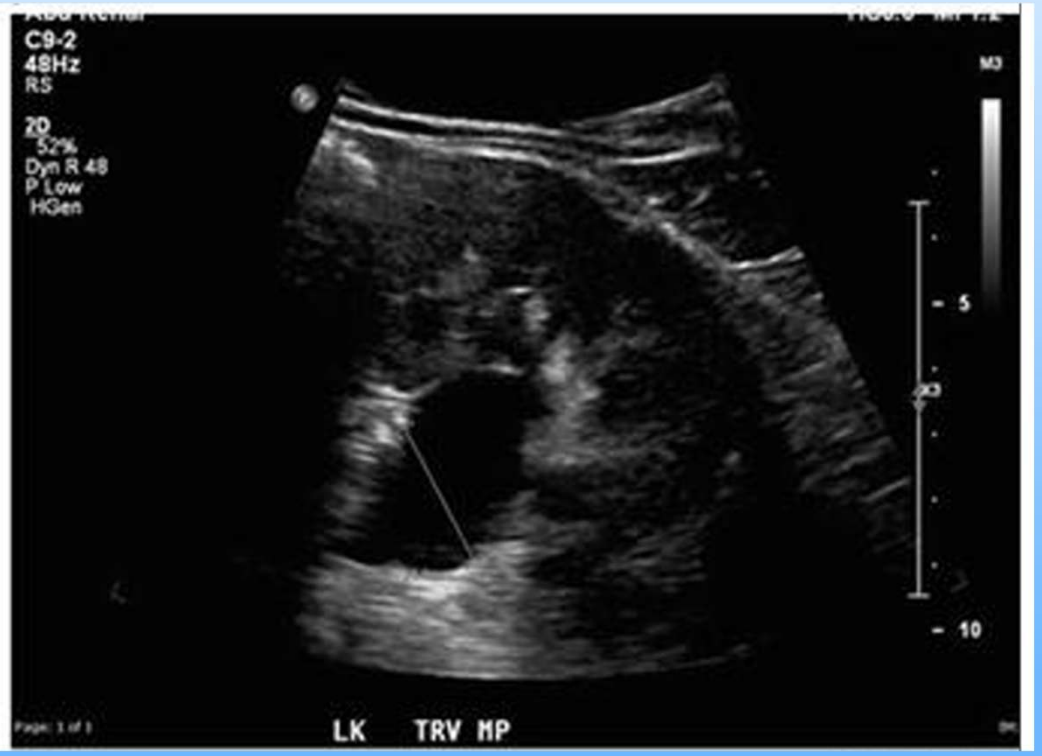




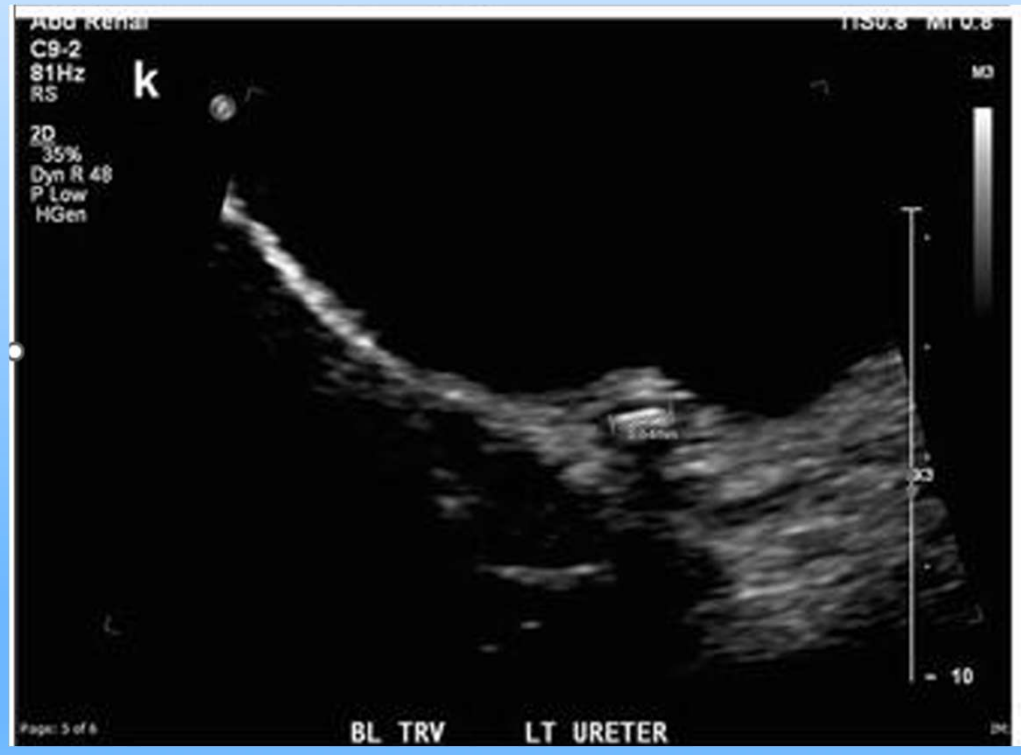
Horseshoe Kidney

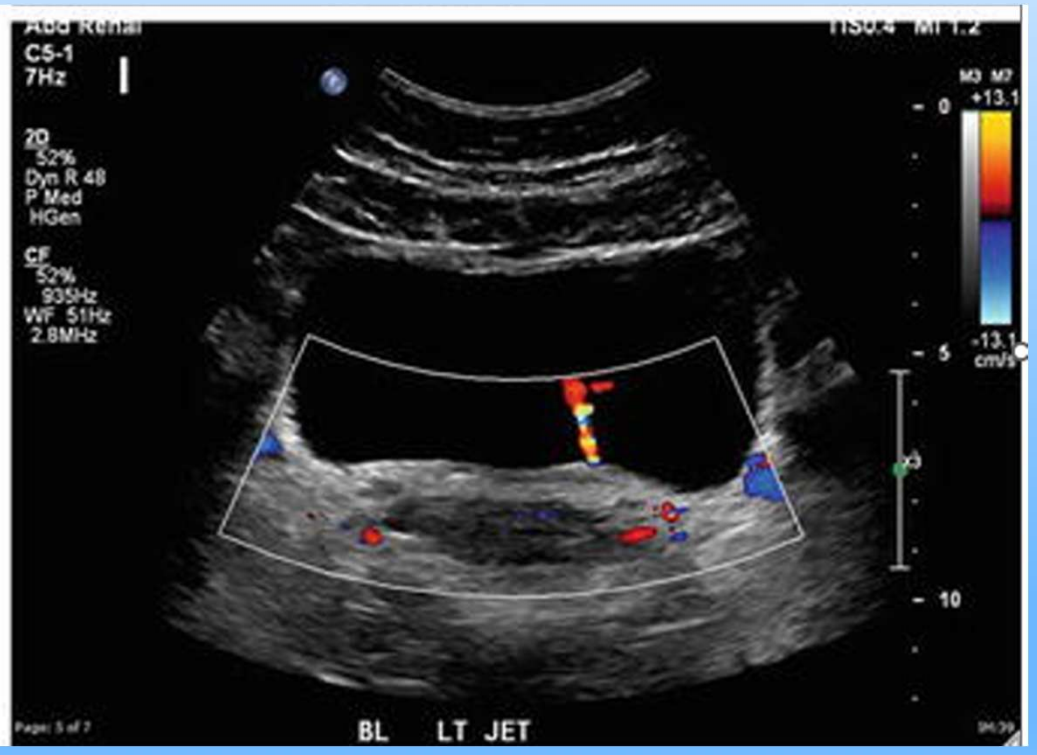
Acquired: Intrinsic and Extrinsic



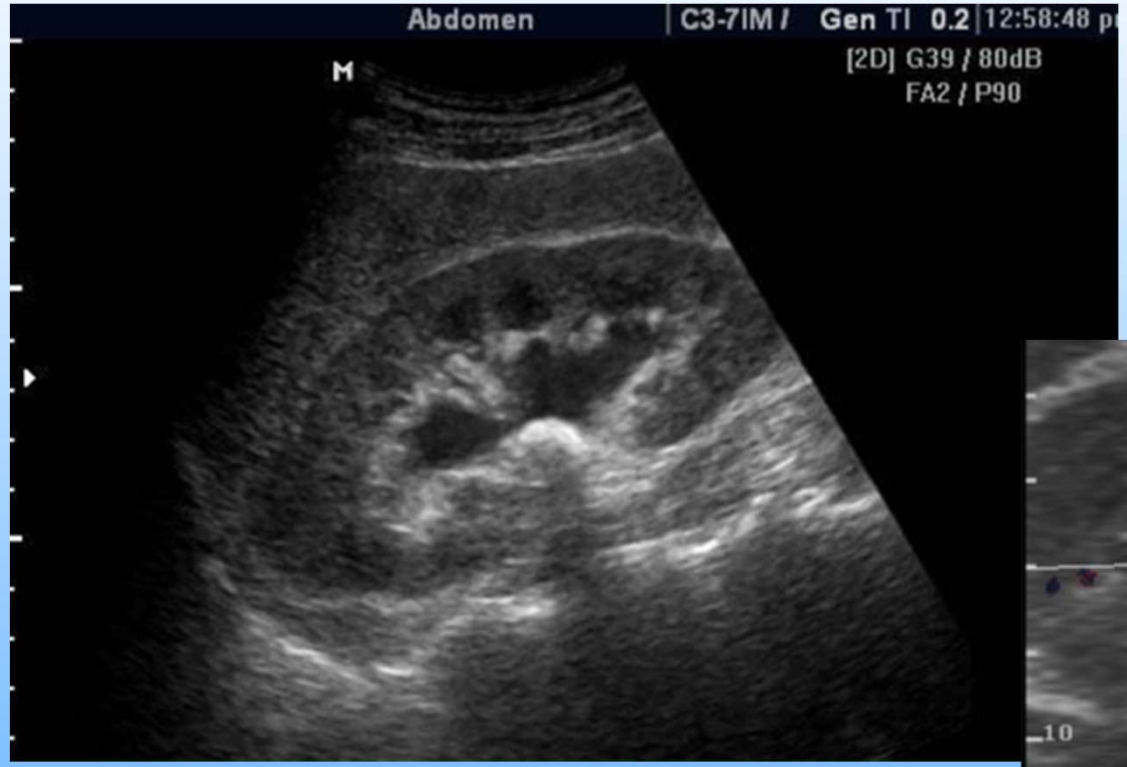


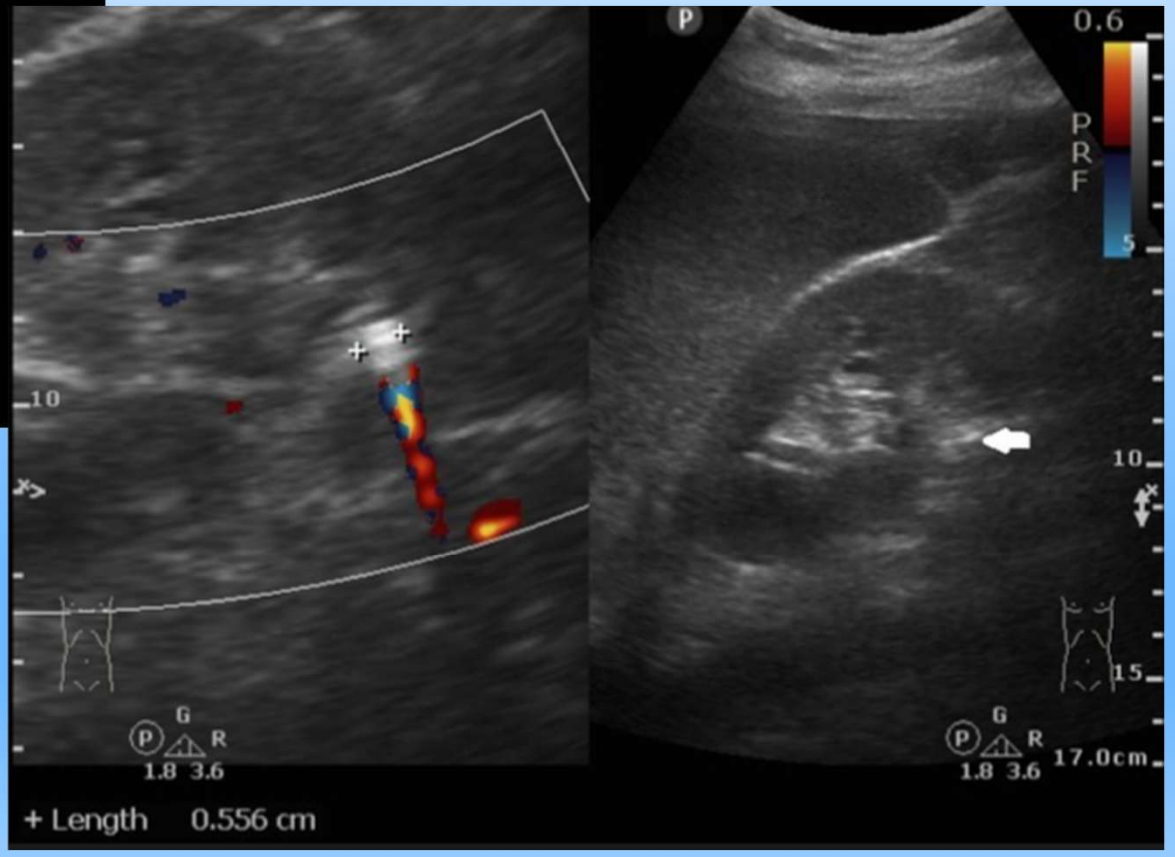
Intrinsic: Urethral obstruction – calculi (distal TCC can cause similar findings of course)



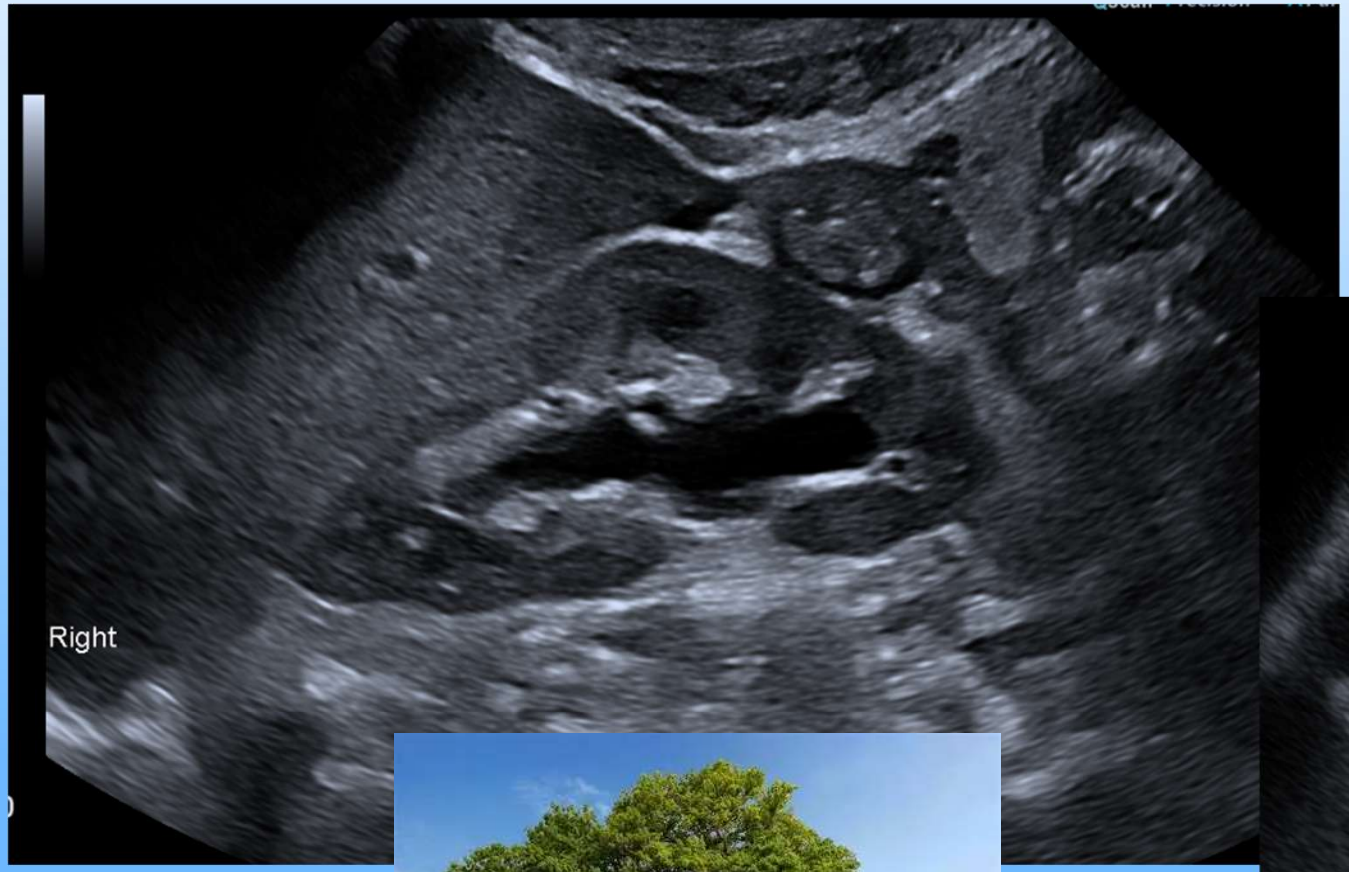


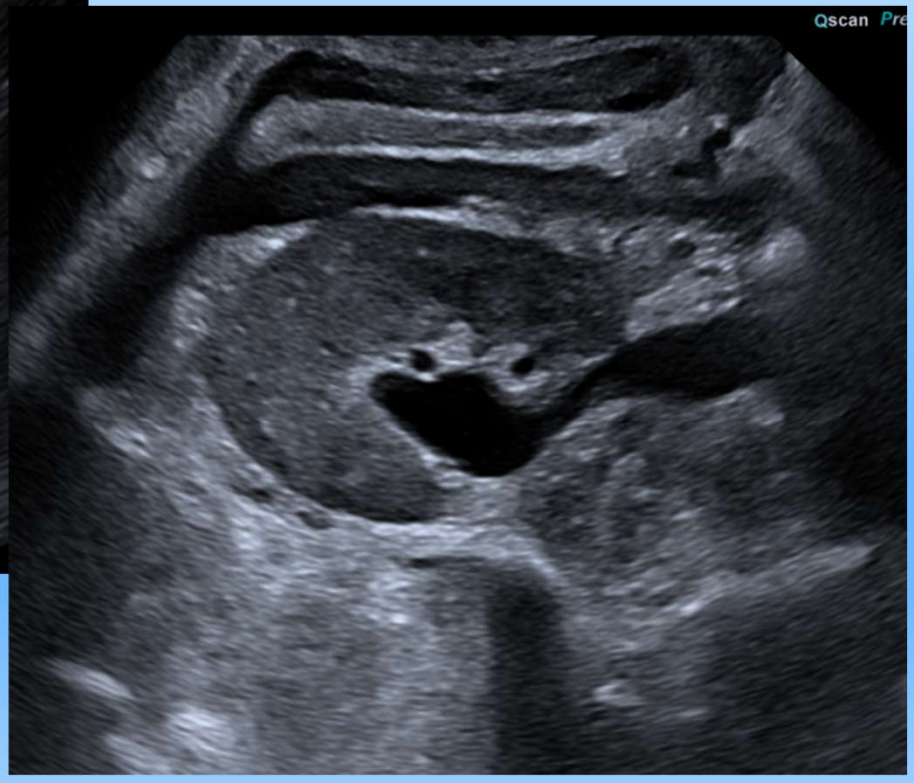
Obstructing Vs non-obstructing calculi

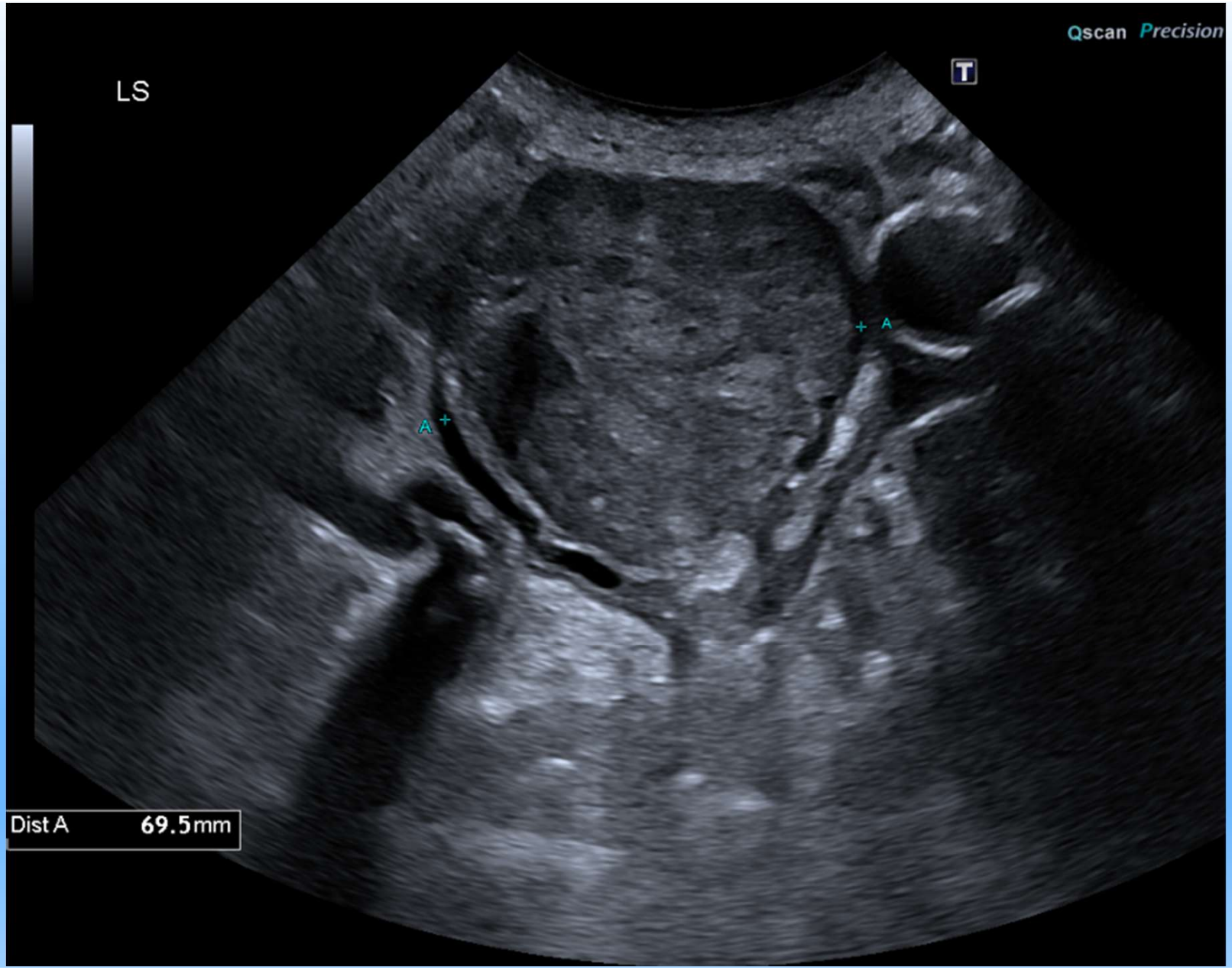


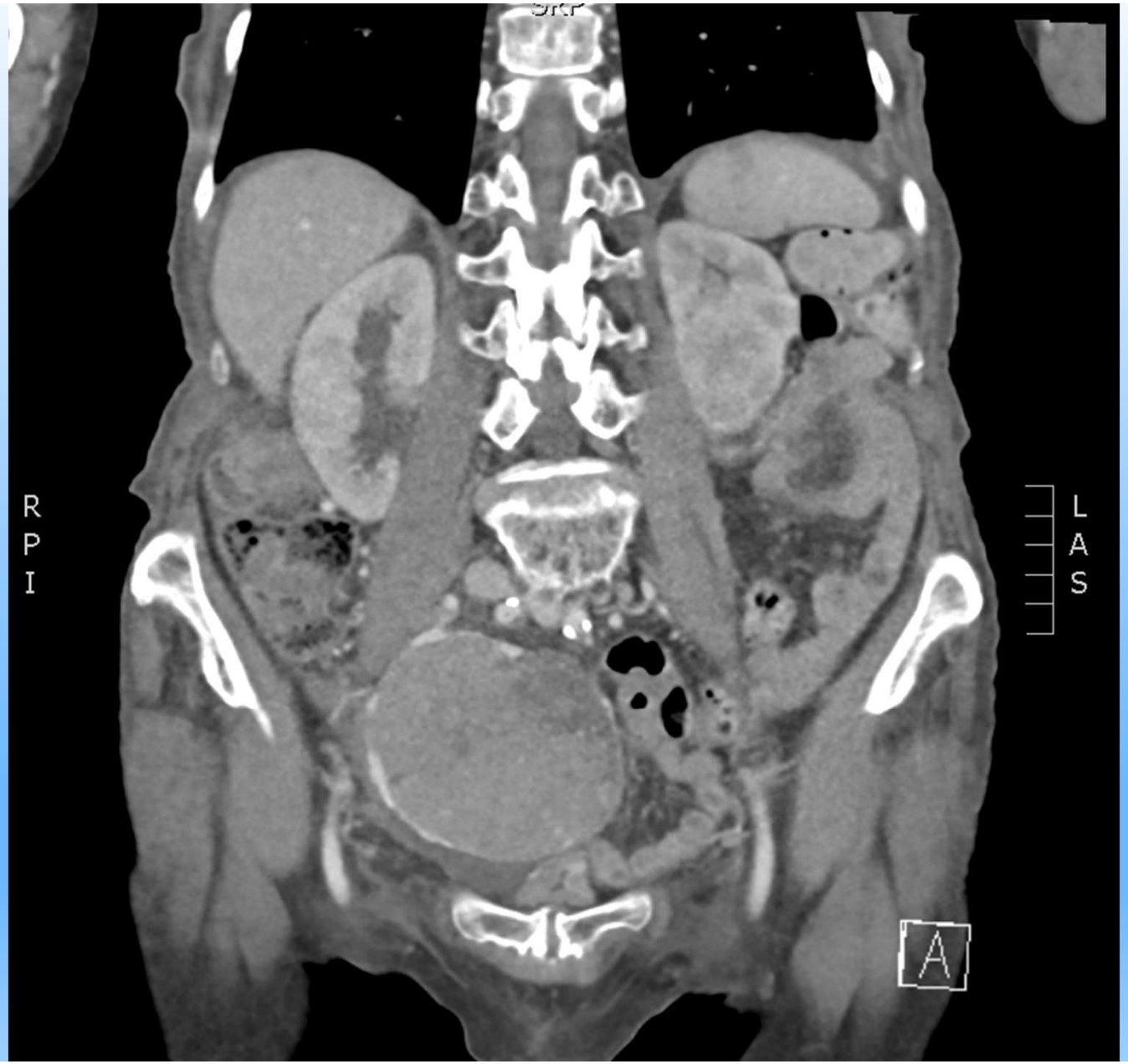


Extrinsic: Compressive tumours

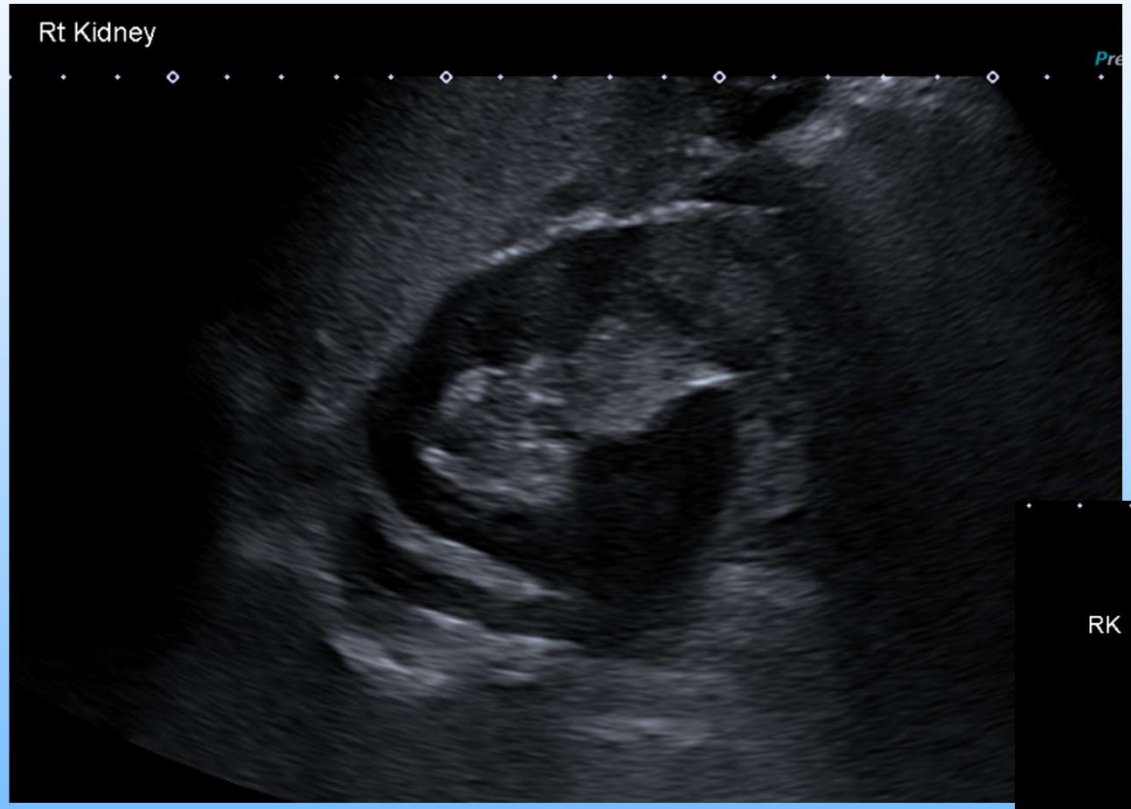




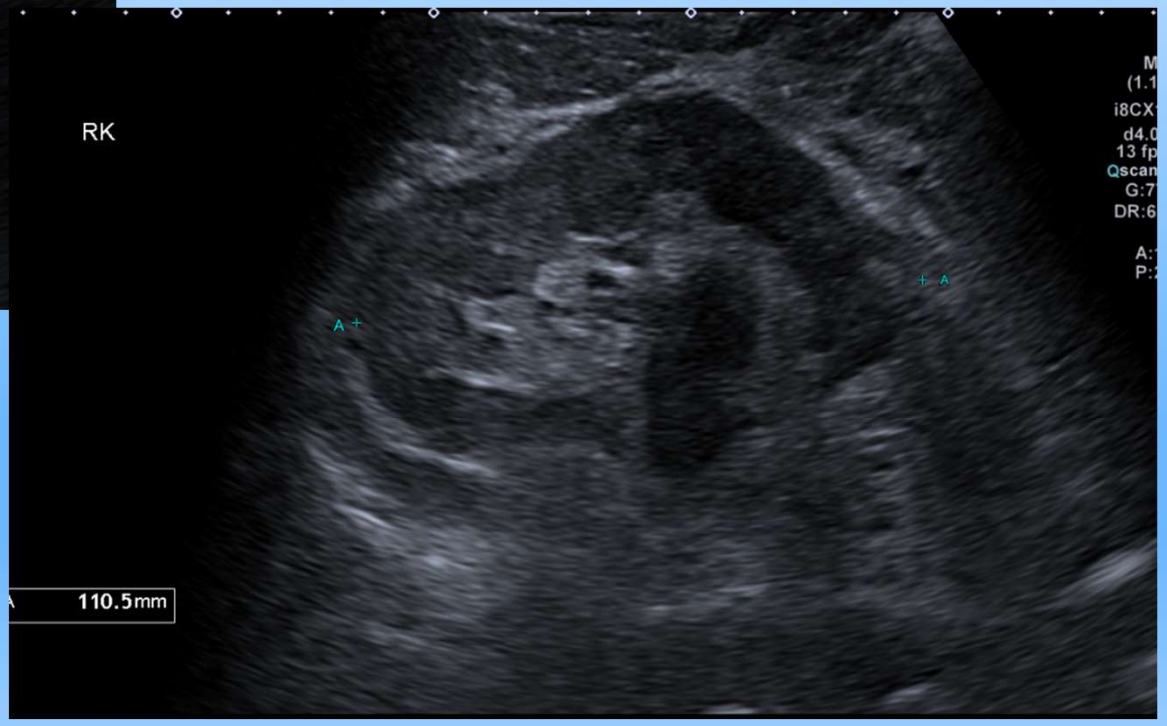

Qscan Precision
LS
T
A
A
Dist A 69.5mm

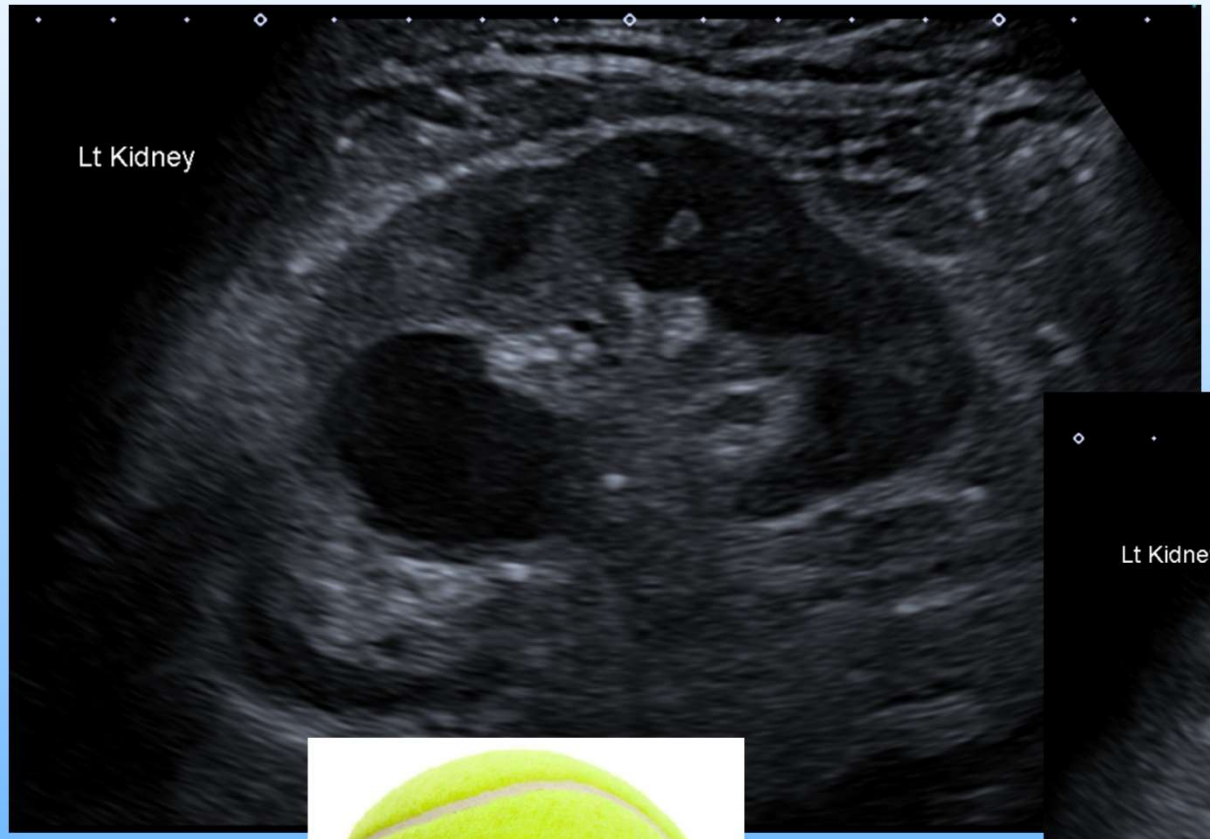


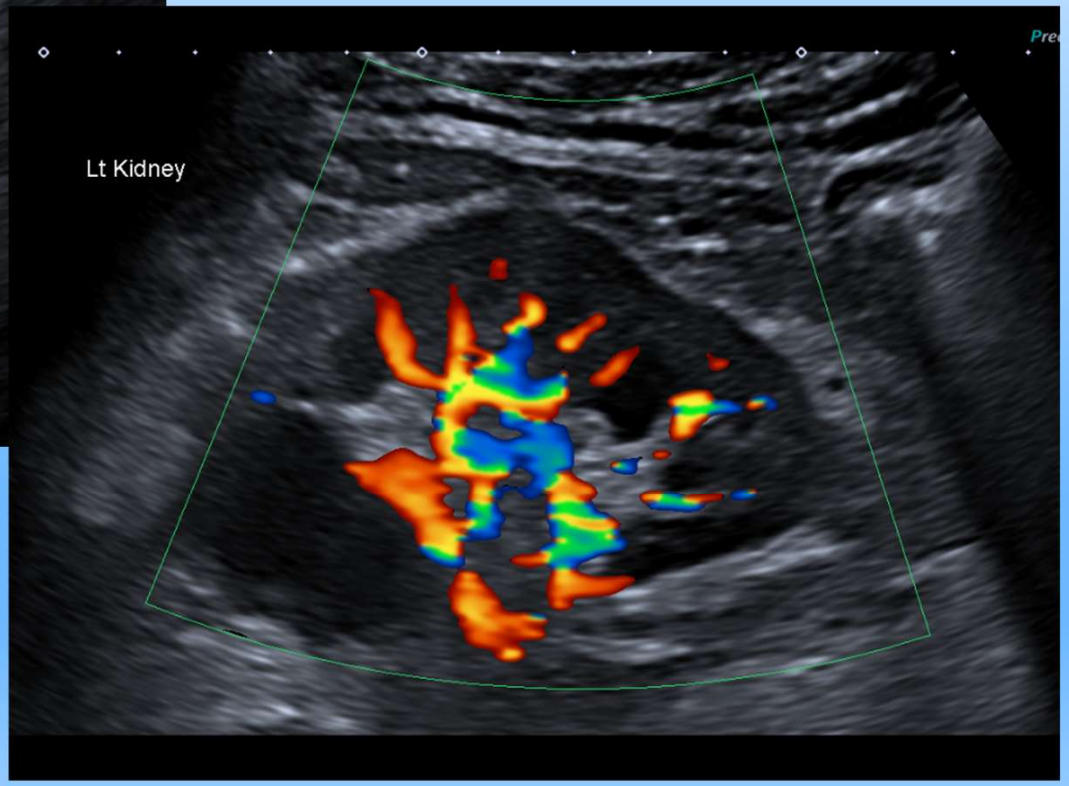
Conclusion:
Appearances are consistent with advanced malignancy with disease likely within the stomach cause serosal disease, ovarian tumours, liver, lung and nodal metastases.



Case 1: Hydronephrosis ?
Not hydronephrosis?



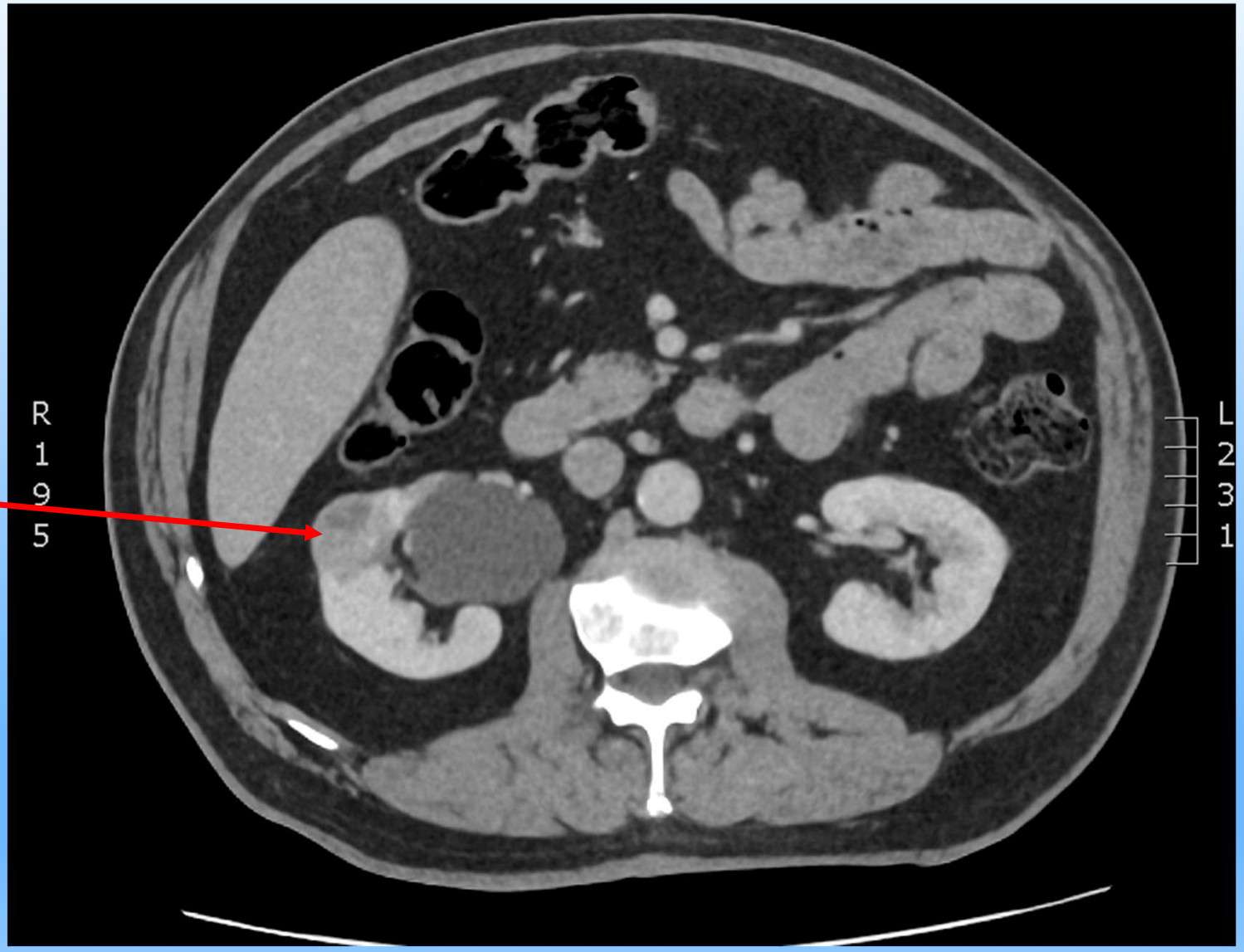

Lt Kidney


Lt Kidney

September 2025:

CT Abdo
Clinical Details:

Anaemia. Declined invasive procedures

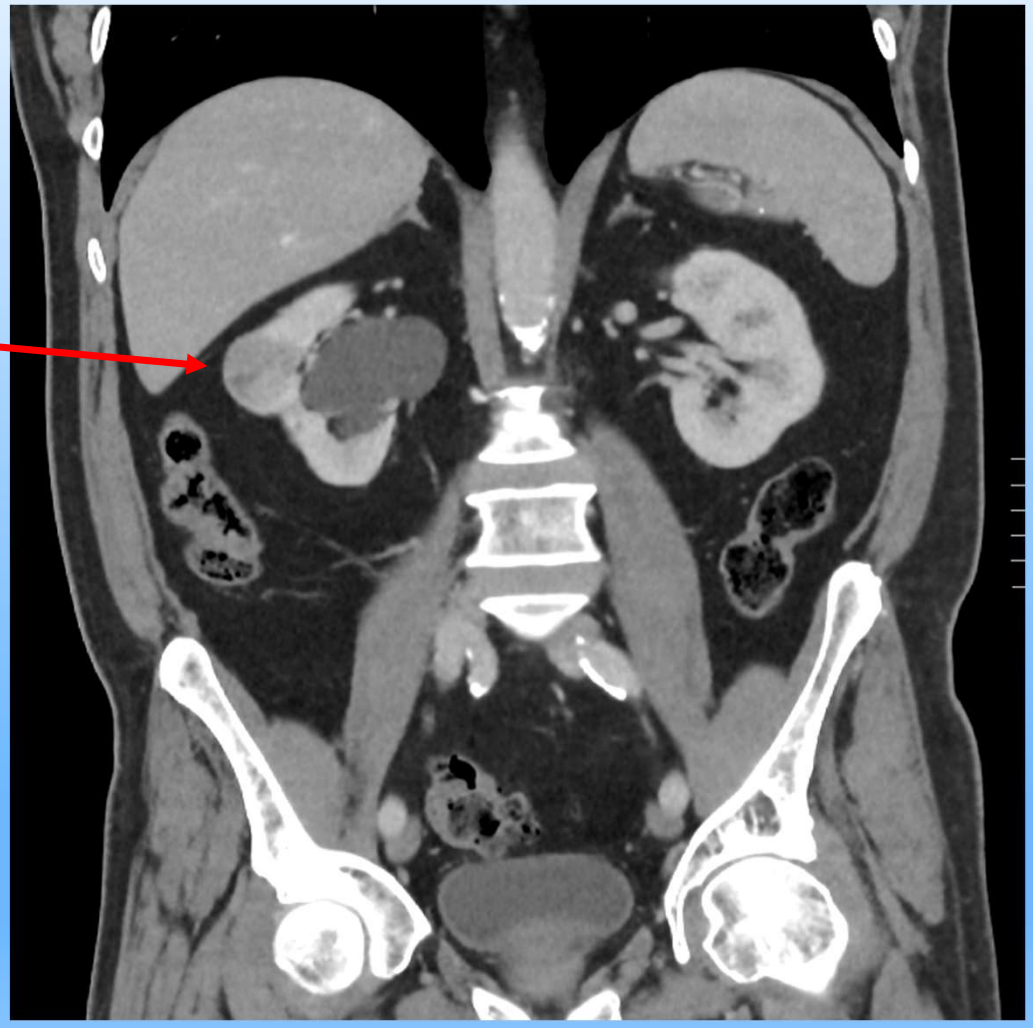


Findings: There is an ill-defined high attenuation renal lesion in the mid-pole of the right anterior cortex measuring 3 x 2.7 cm with Hounsfield number of 76. This is suspicious for RCC. Bilateral type I and type II Bosniak renal cysts measuring up to 5.8 cm are also noted. No hydronephrosis.

No sinister focal liver lesion. Large gallstone is present. Normal pancreas, adrenals.

Calcified granuloma in the spleen is noted. No intra-abdominal lymphadenopathy, ascites. Non-complicated colonic diverticulosis is present.

CONCLUSION:
Probable right RCC warrants a dedicated CT renal protocol scan and staging CT chest. Urology referral is advised.



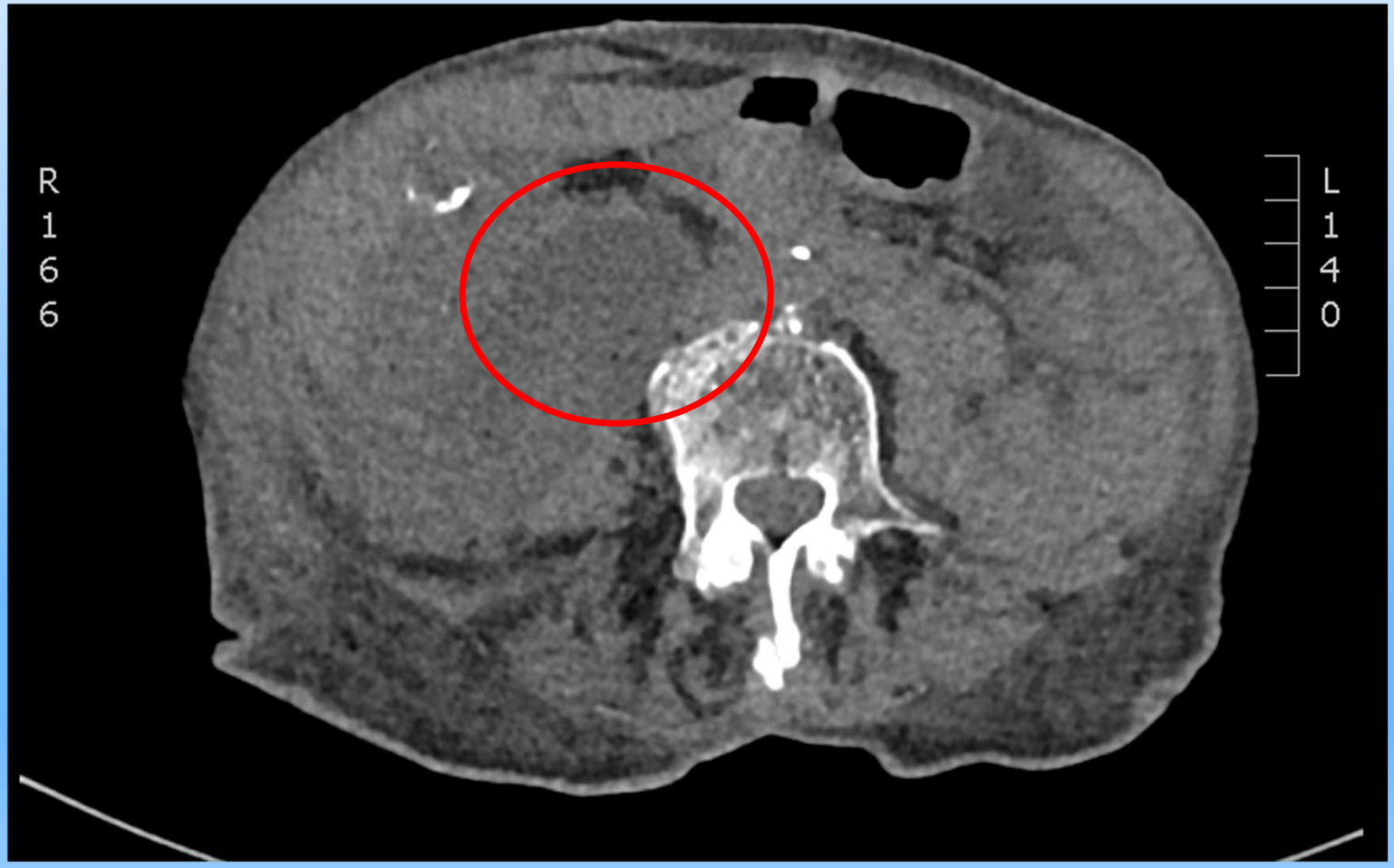
Case 2: Hydronephrosis ? Not hydronephrosis?

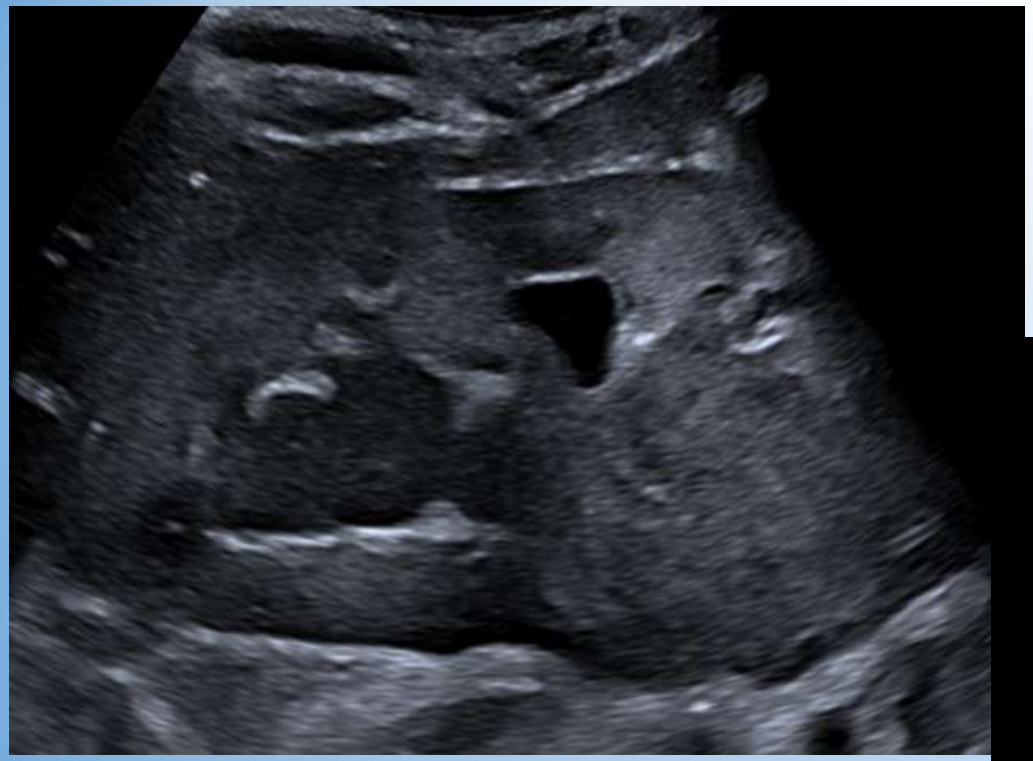
Previous left nephrectomy

Known Rt RCC

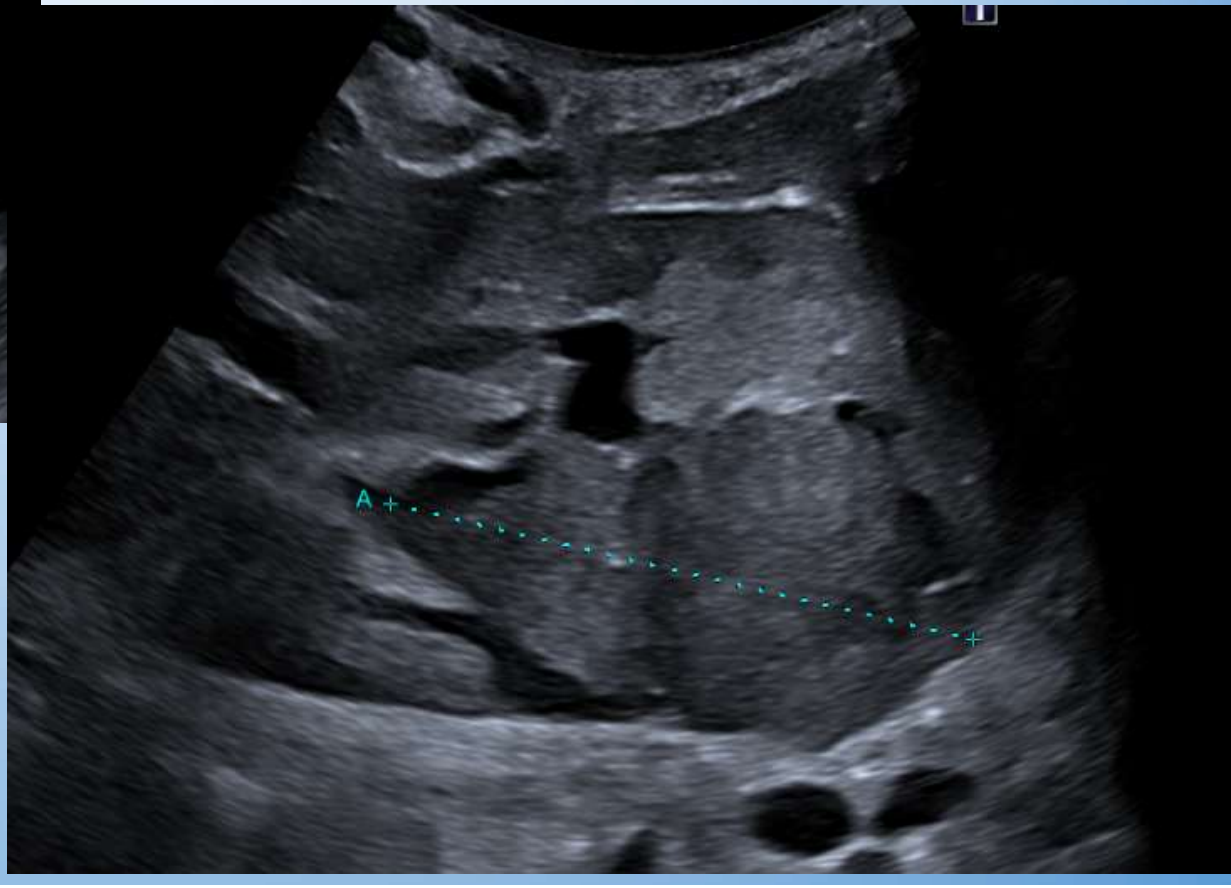
CT Conclusion:

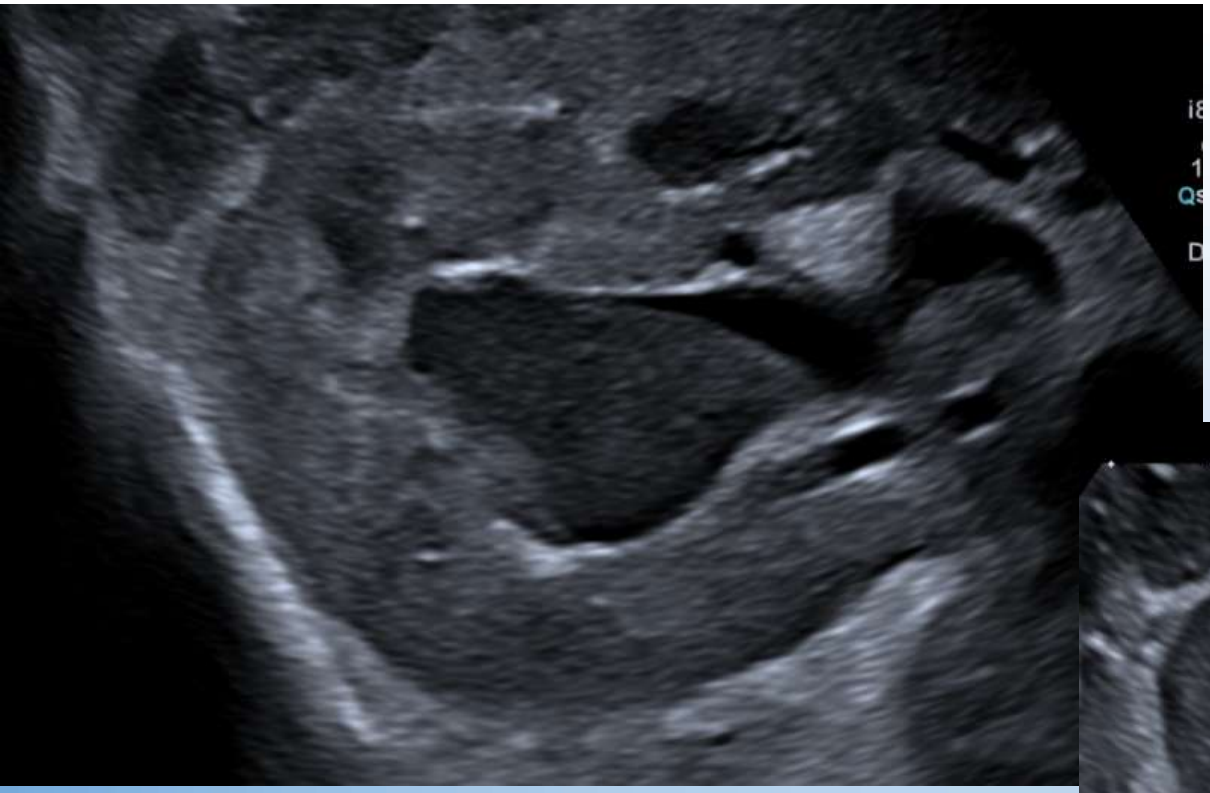
Interval enlargement is seen of the right renal lesion with associated increase in the degree of hydronephrosis.

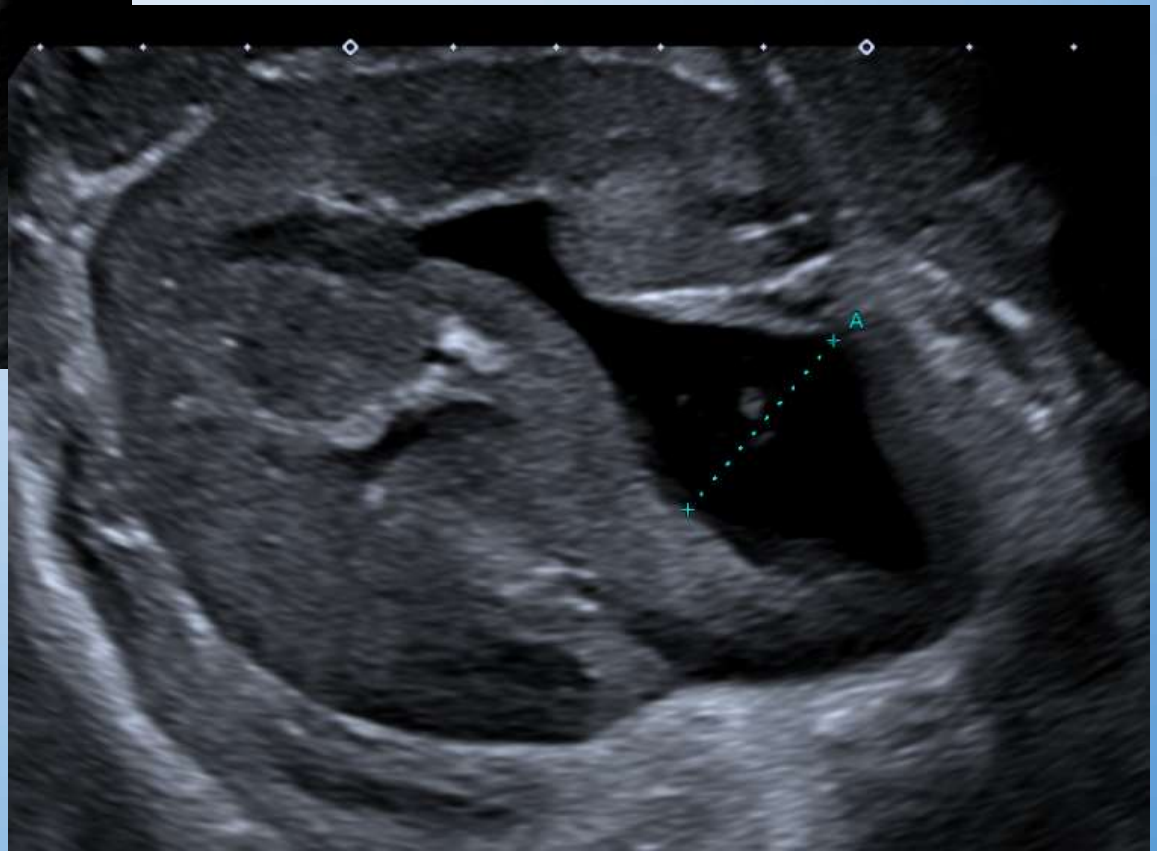




US Request 10/04/2025
h/o left nephrectomy and right renal cell carcinoma. Increasing hydronephrosis on CT – ? Amenable for nephrostomy






A

Radiologist comment: I have been asked for my opinion regarding nephrostomy of the right-sided single kidney. Creatinine is increased but the patient is catheterised and passing urine, good volumes. Findings are suggestive of a degree of pre-renal failure.

The ultrasound imaging is exceptional on this patient relative to the CT. This patient has renal cell carcinoma in the lower pole of the right kidney.

The apparent hydronephrosis seen on the recent CT is actually due to extensive transitional cell carcinoma expanding the calyces of the right kidney in addition to the RCC. There is no scope for right-sided nephrostomy in this case. Discussed with urology.

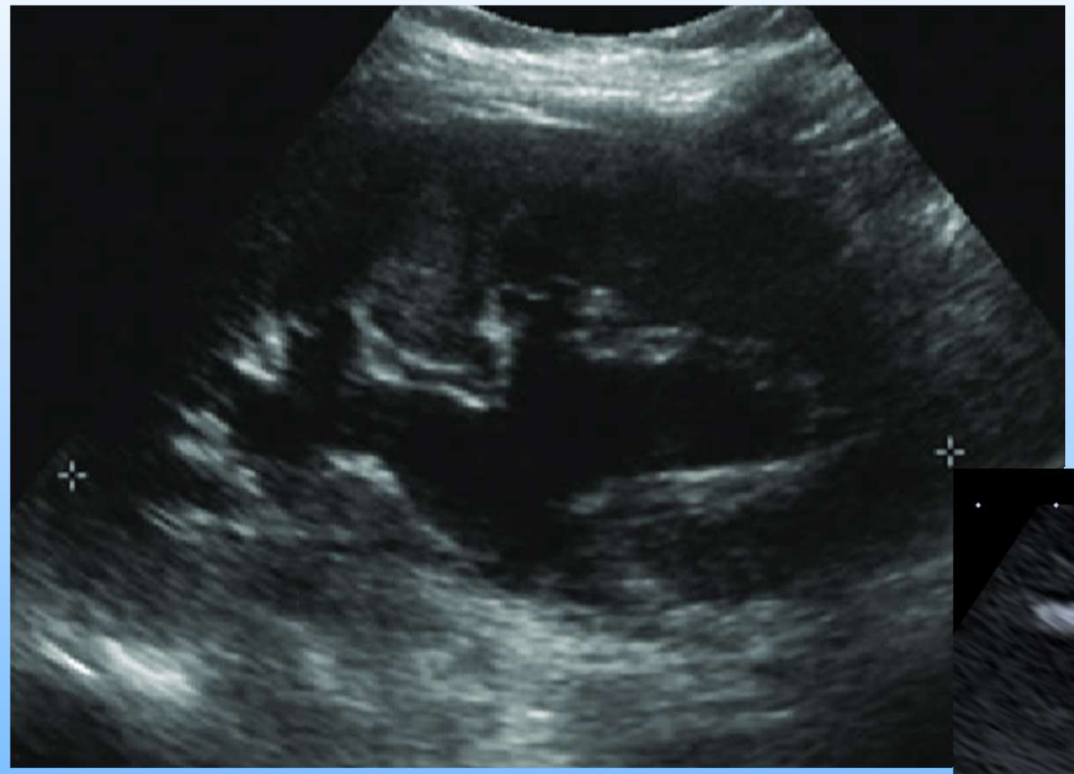
When and why are we looking for hydronephrosis?

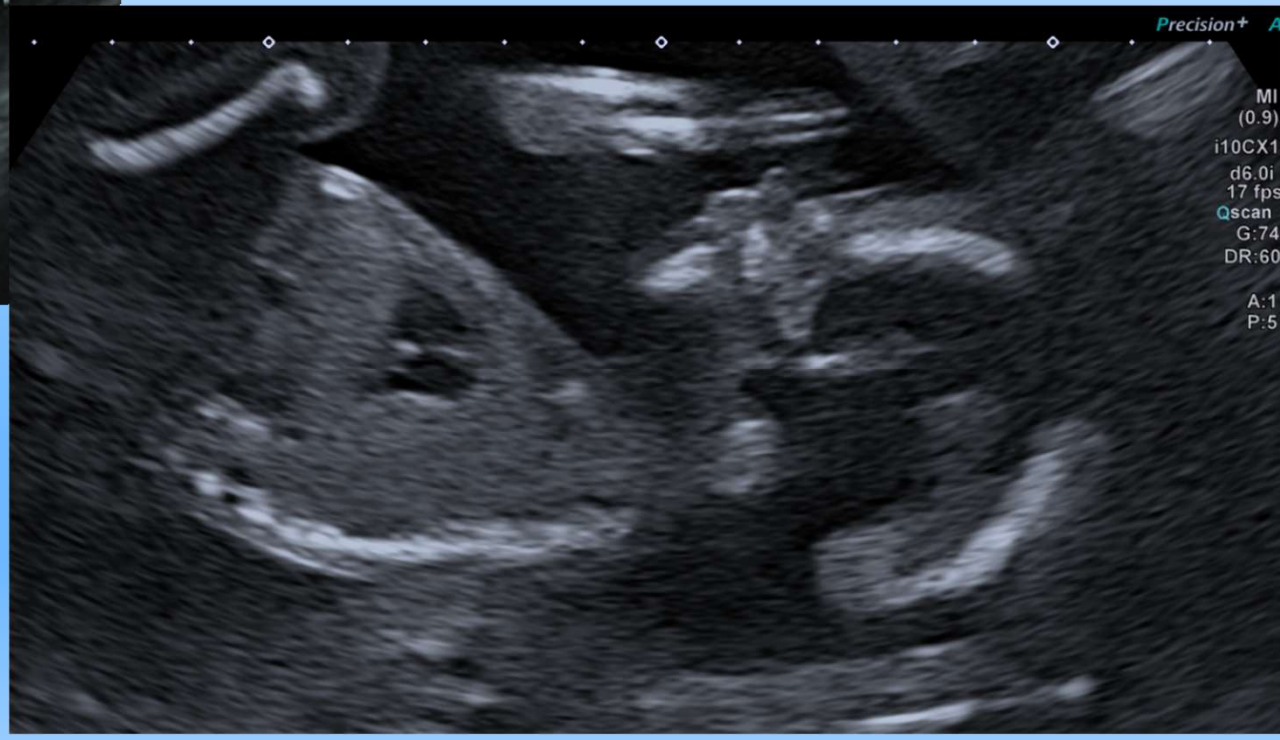
- Hydronephrosis is a sign, not a disease, indicating impaired urine flow.
- Pain
- Fever
- Rising creatinine
- Reduced urine output

When and why are we looking for hydronephrosis?

- Early detection is crucial to prevent renal damage.
- Imaging helps differentiate obstructive vs non-obstructive causes and guides management.
- By understanding the types, causes, and imaging features, clinicians can accurately diagnose hydronephrosis and determine appropriate interventions

Presentation 1: Pain ? Cause

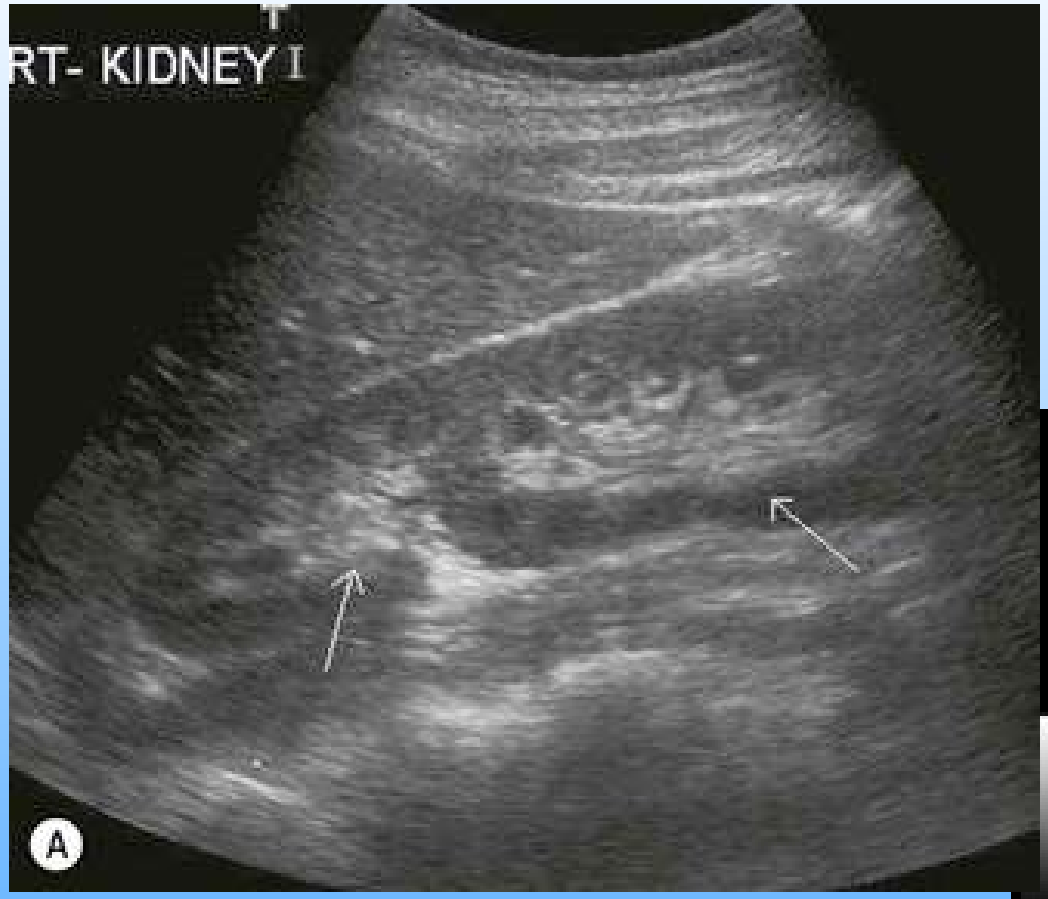


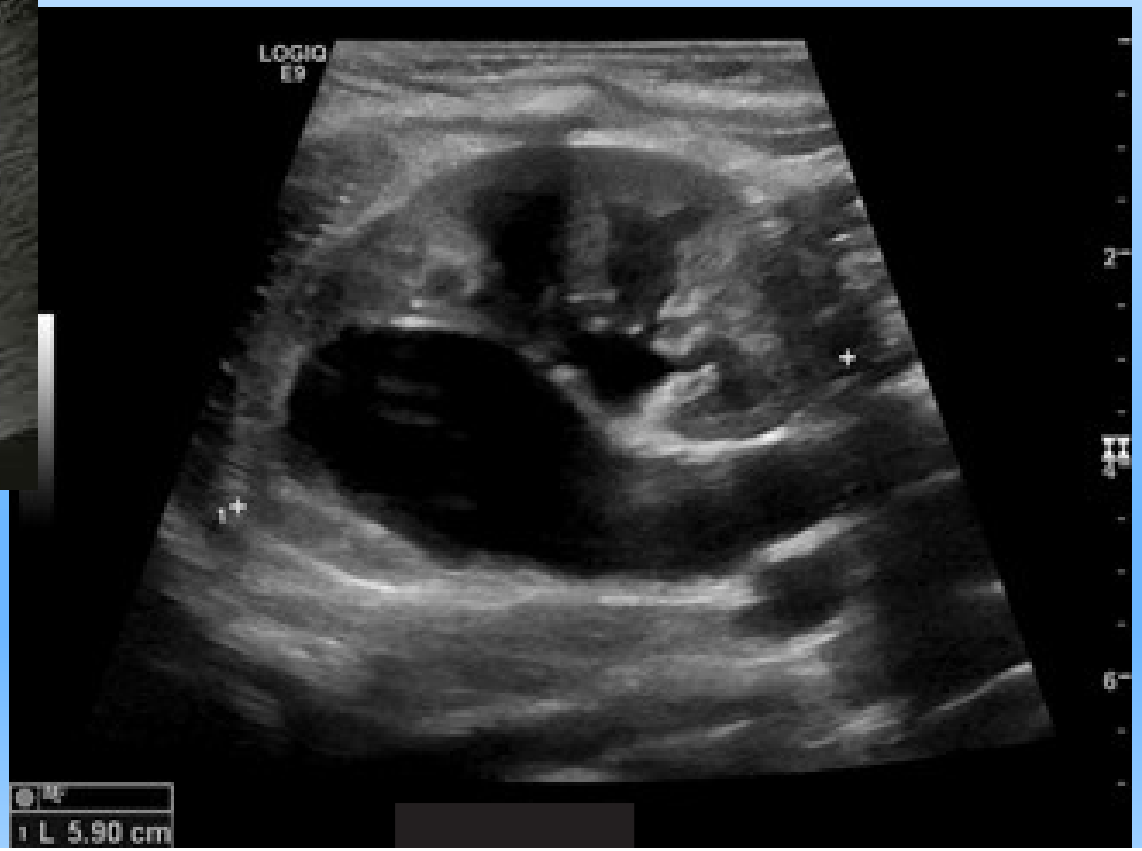


Maternal Hydronephrosis

- It is estimated that up to 90% of women have some degree of asymptomatic dilatation of the renal calyces, the renal pelves and the upper two-thirds of the ureters during pregnancy.
- It is thought to be most pronounced in primigravid females.
- The vast majority of asymptomatic cases are treated conservatively
- Most cases of physiological calyectasis do not impair renal function.

Presentation 2: Pain & fever ?
Cause

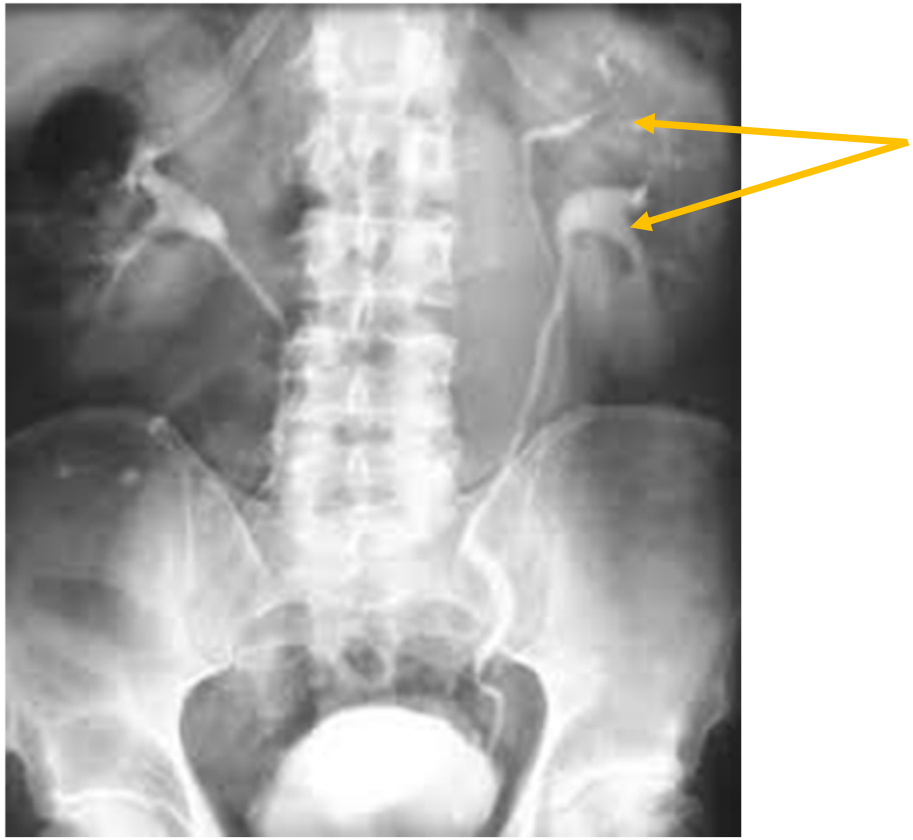




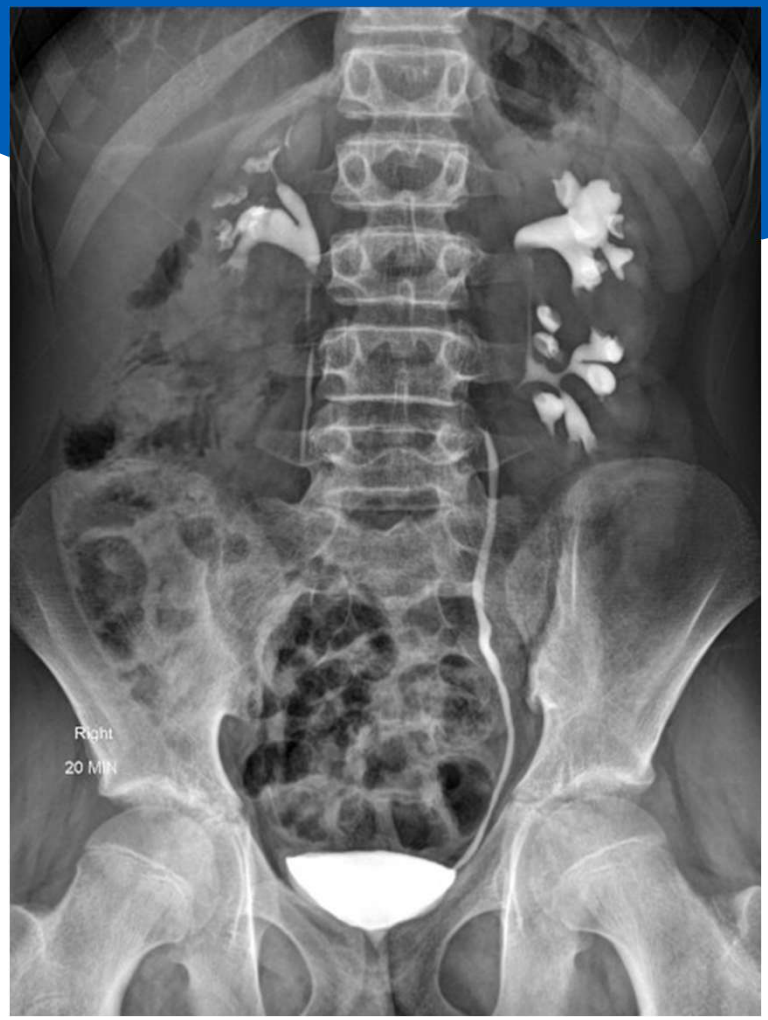
Duplex Kidneys

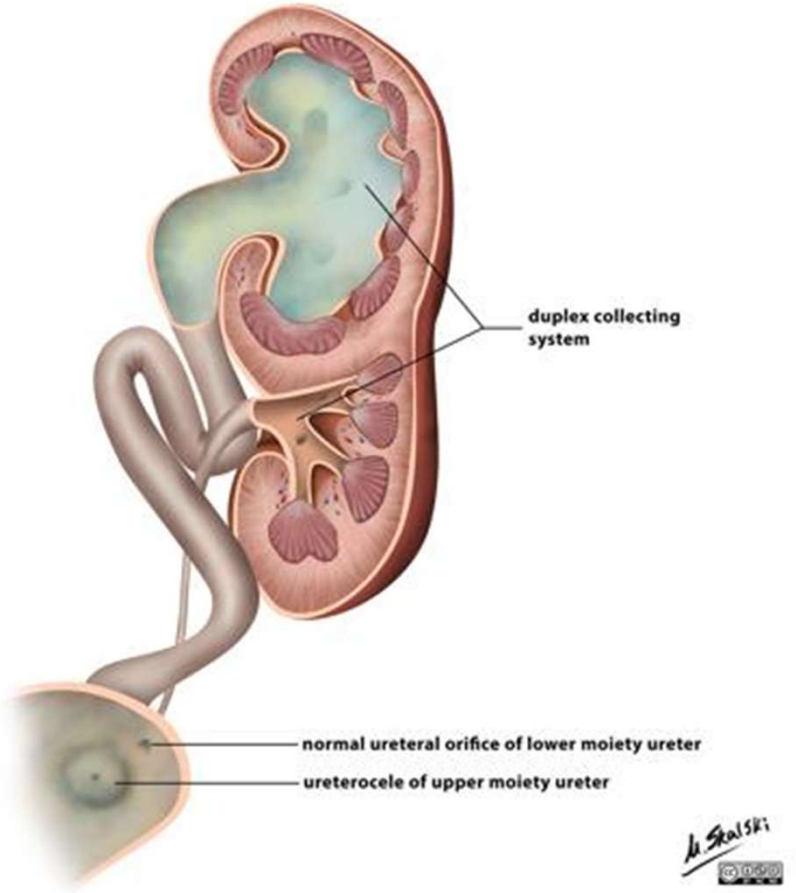
- Clinical Radiology 1976 – Incidence of 1.8%
- 27% of duplex kidneys vs 3% of non-duplex have evidence of congenital obstruction

- In severe cases that are left untreated, the kidney(s) may become scarred, which could lead to loss of kidney function and subsequent kidney failure requiring surgery.
- Early diagnosis is crucial



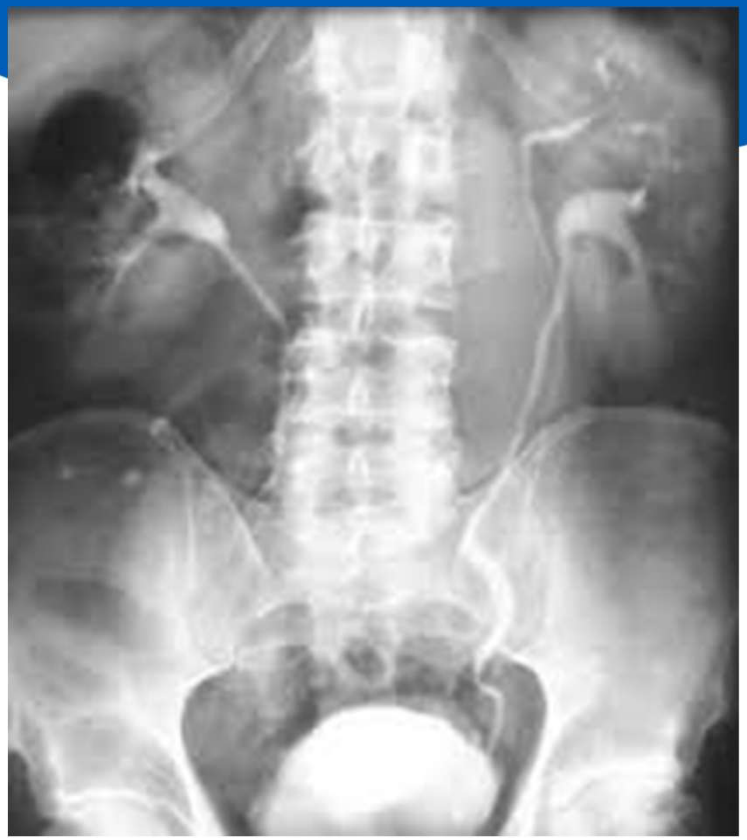
Pyonephrosis of a duplex kidney





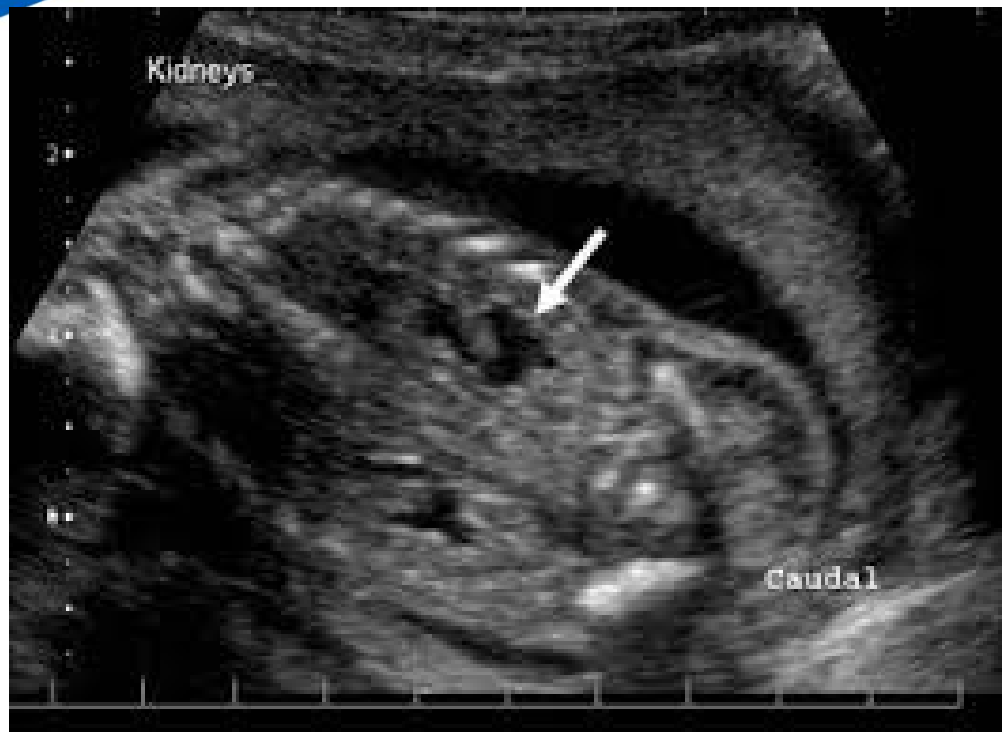
https://radiopaedia.org/articles/duplex-collecting-system?case_id=duplex-kidney-4

When do we now diagnose?



1976

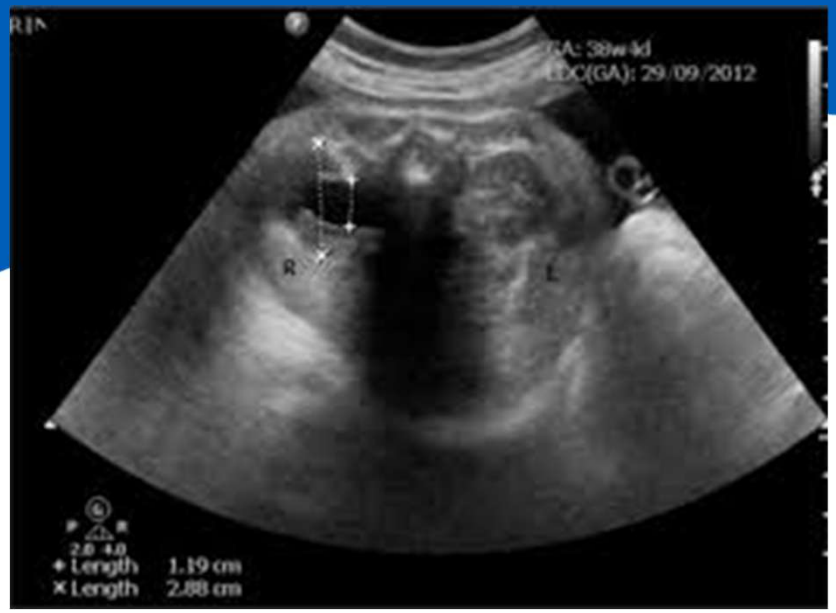
Antenatal ultrasound

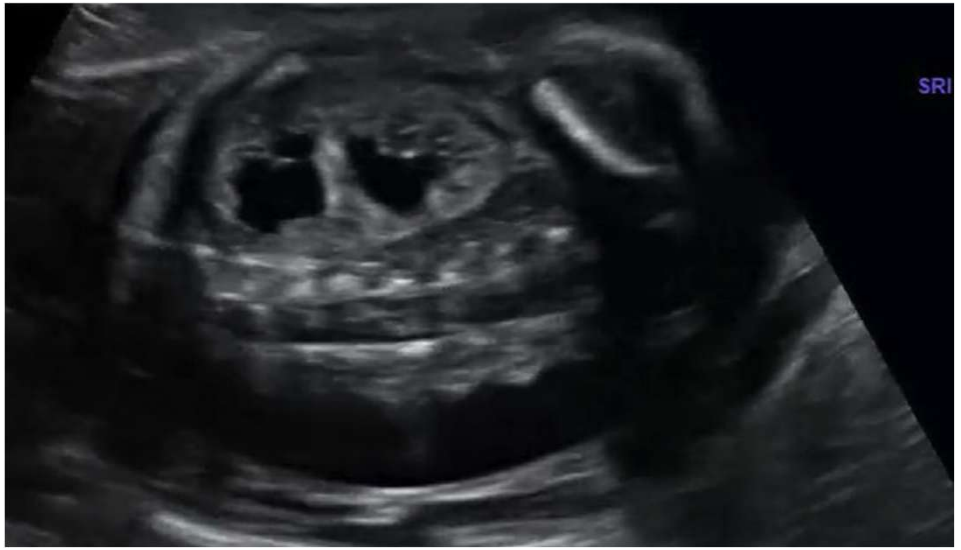


2026

Antenatal Imaging

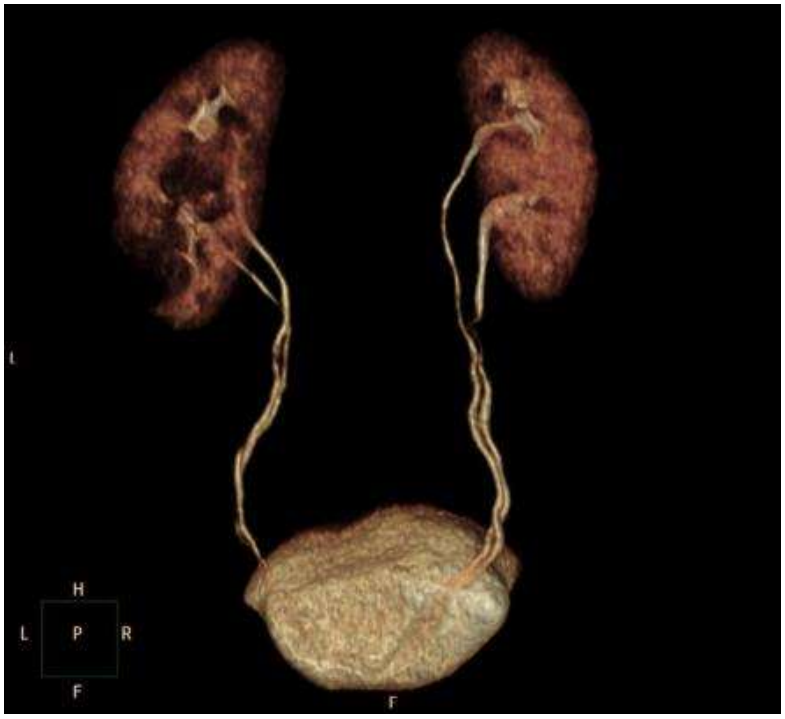
- Commonly seen at 20-week scan
- Estimated incidence of neonatal hydronephrosis that has clinical significance is 1 in 600
- Most cases will resolve without intervention



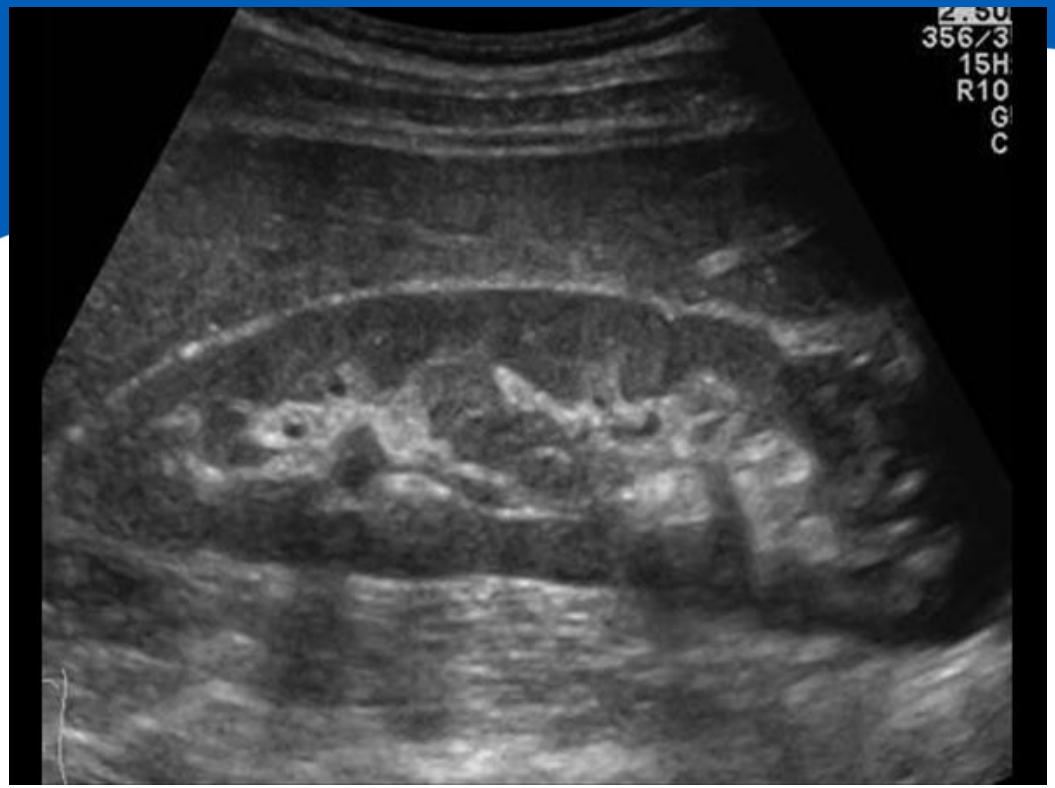


Duplex kidney follow-Up

- A systematic review found that 98% of patients with mild and 90% of cases of moderate dilation of the renal pelvis resolve spontaneously by 12 to 14 months of life
- Surgery is usually indicated only when the hydronephrosis is worsening or when there is a significant difference in function between kidneys



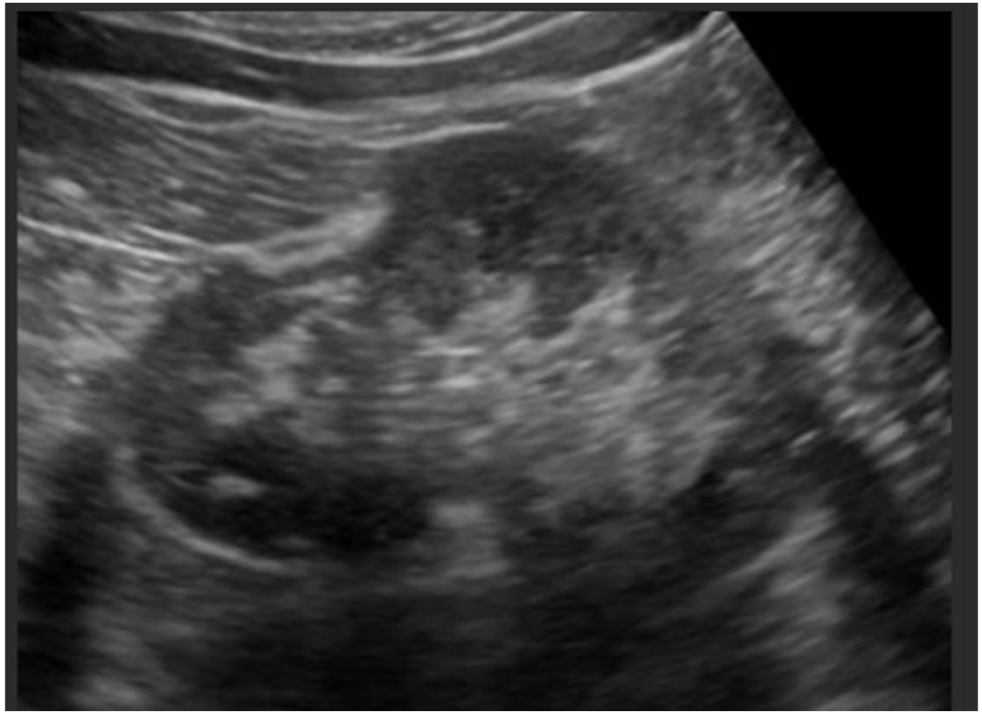
Follow Up



- Much controversy exists over the optimum timing of follow-up postnatal imaging
- A follow-up US is generally recommended before 4 weeks of age to confirm the absence of hydronephrosis
- A series of two normal postnatal renal US examinations can safely exclude obstructive hydronephrosis and dilating vesicoureteral reflux

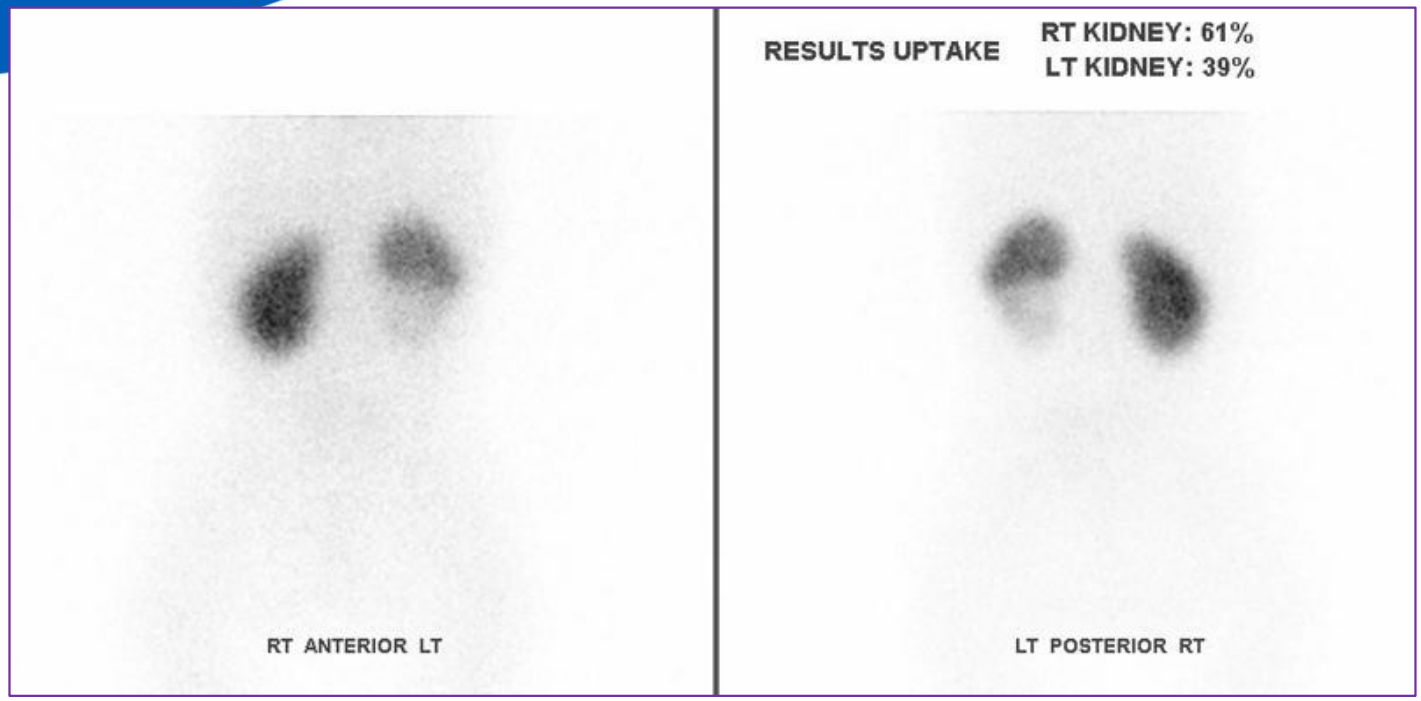
Why Follow Up / Treat?

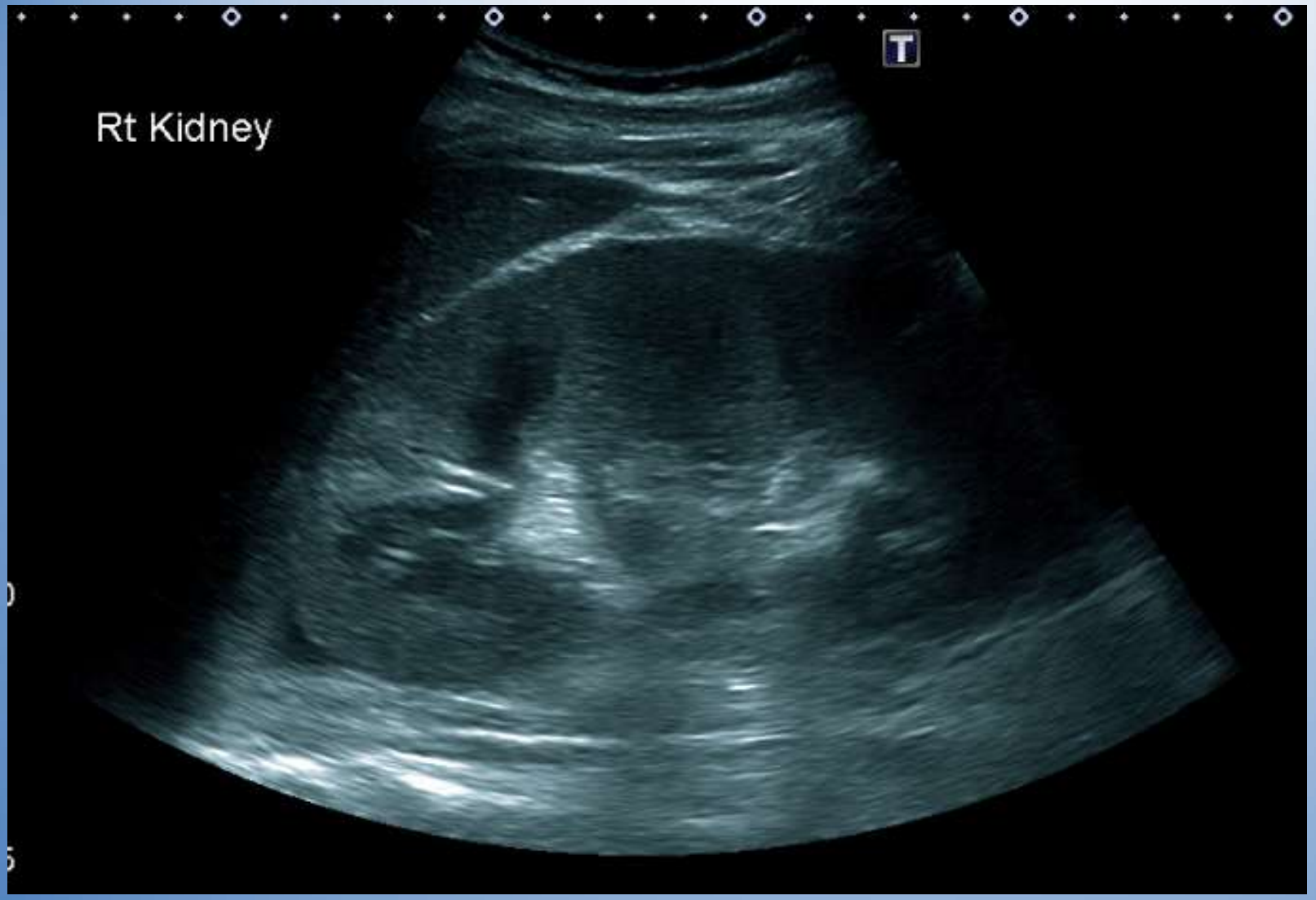
- Dilatation doesn't generally cause any long-term problems if it's diagnosed and treated promptly.
- However, the condition can increase likelihood of urinary tract infections (UTIs).



Why Follow Up / Treat?

- Late diagnosis (2 – 4 years of age) commonly associated with infection
- Nuclear med scans often demonstrate reduced function - either due to dysplastic moiety or scarring from previous infections.





Presentation 3:
Rising creatinine
Reduced urine outcome

? Cause

Acute Kidney Injury

- The older term is 'acute renal failure' (ARF).
- Acute kidney injury (AKI) is a rapid deterioration of renal function, resulting in inability to maintain fluid, electrolyte and acid-base balance.
- It is detected and monitored by serial serum creatinine readings primarily, which rise acutely
- The presentation will depend on the underlying cause and severity of AKI.

Acute Kidney Injury

- It is estimated that 15% of adults admitted to hospital develop AKI
- AKI is responsible for a 20-30% in-patient mortality rate

- The mortality rate varies greatly depending on the severity, setting, and many patient-related factors but it is a **KILLER**.
- Estimated that improving care could save 12,000 lives in England and save the NHS £150 million per year (2013)

NICE guideline NG 148 (Oct 2024)

Acute kidney injury: prevention, detection and management of acute kidney injury up to the point of renal replacement therapy

Ultrasound

Do **not** routinely offer ultrasound of the urinary tract when the cause of the acute kidney injury has been identified.

Acute Kidney Injury - Causes

Pre-Renal 40-70%	Renal 10-50%	Post-Renal 10%
Renal Hypoperfusion	Acute tubular necrosis	**Obstruction**
• Hypovolaemia	(Ischaemia of renal tubules)	
• Sepsis	Drugs	
• CCF	Contrast agents	
• Cirrhosis	Haemoglobinuria	
• NSAIDs or ACEi	myeloma	
	Vasculitis	

Assessment and Investigations

- History
- Examination
- Urinalysis
- Blood Tests
- Ultrasound
  - But ONLY when the cause of the acute kidney injury has NOT been identified
  - Risk of urinary tract obstruction

NICE guideline NG 148 (Oct 2024)

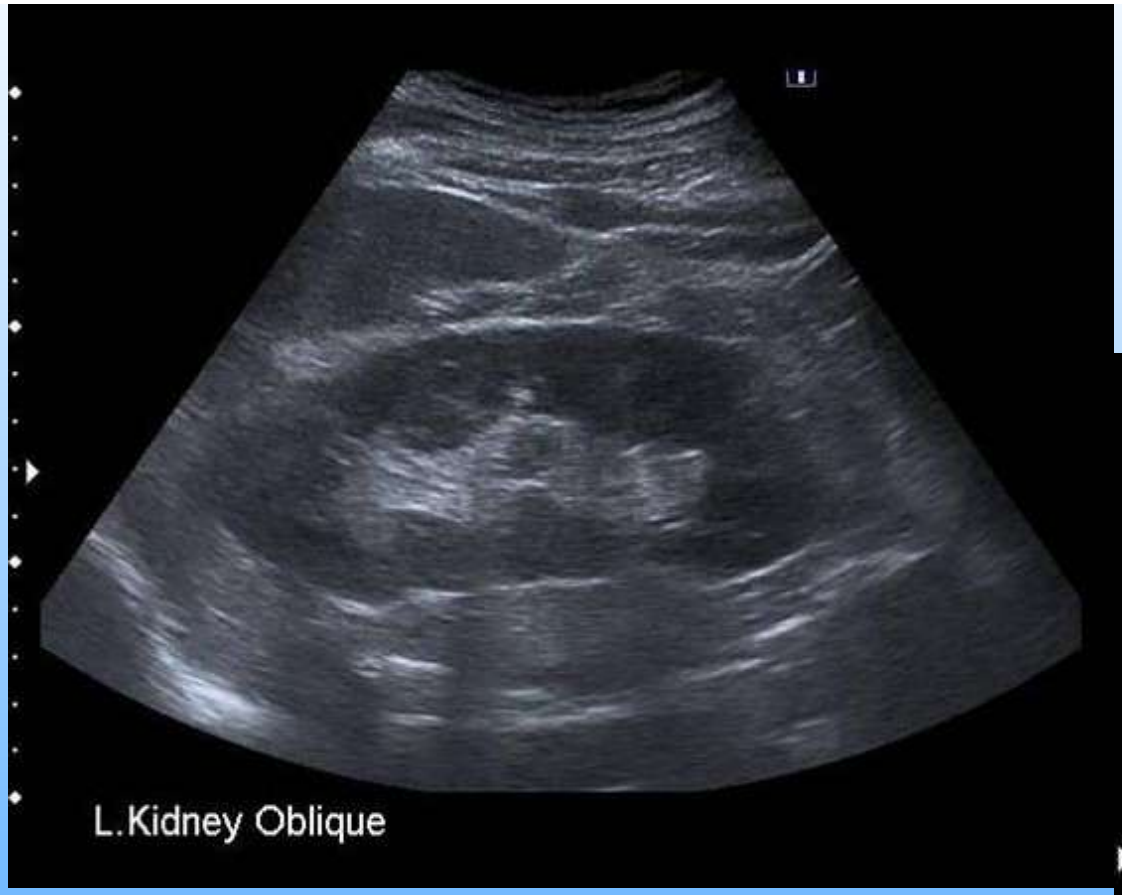
Ultrasound

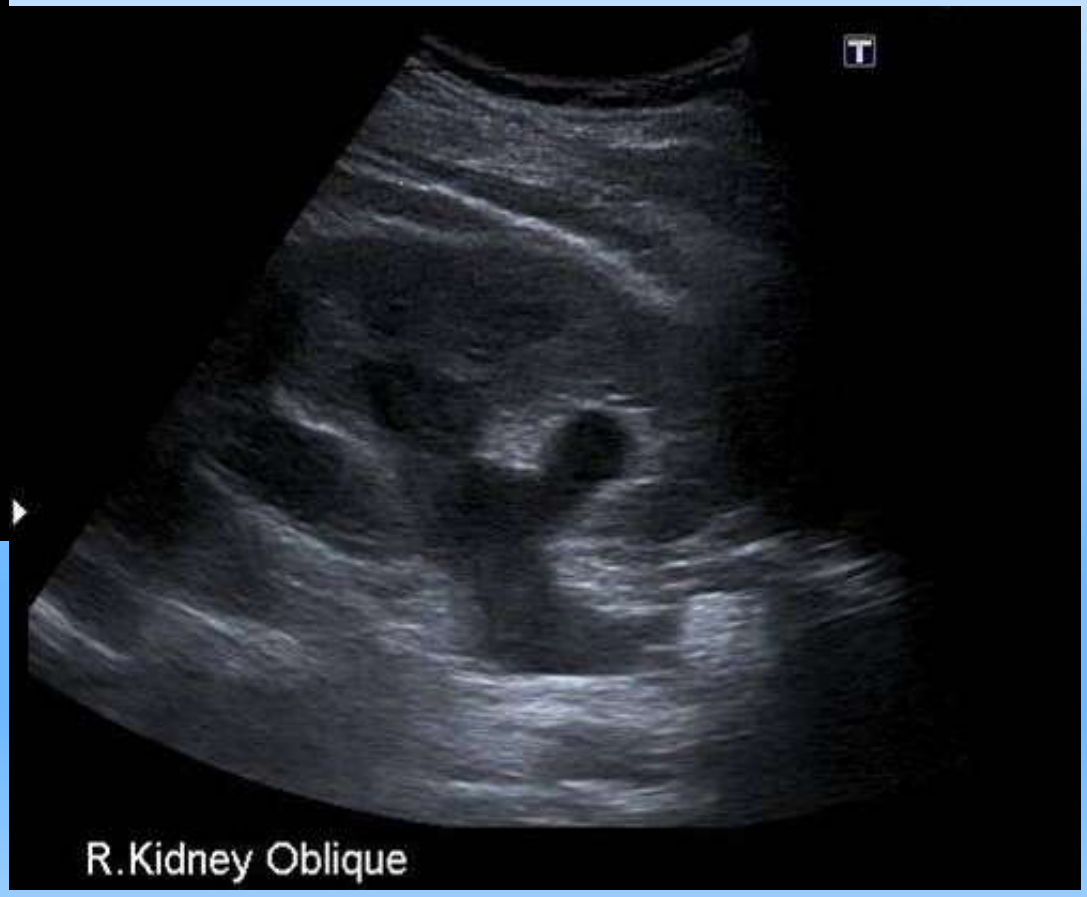
When pyonephrosis (infected and obstructed kidney[s]) is suspected in adults, children and young people with acute kidney injury, offer immediate ultrasound of the urinary tract (to be performed within 6 hours of assessment)

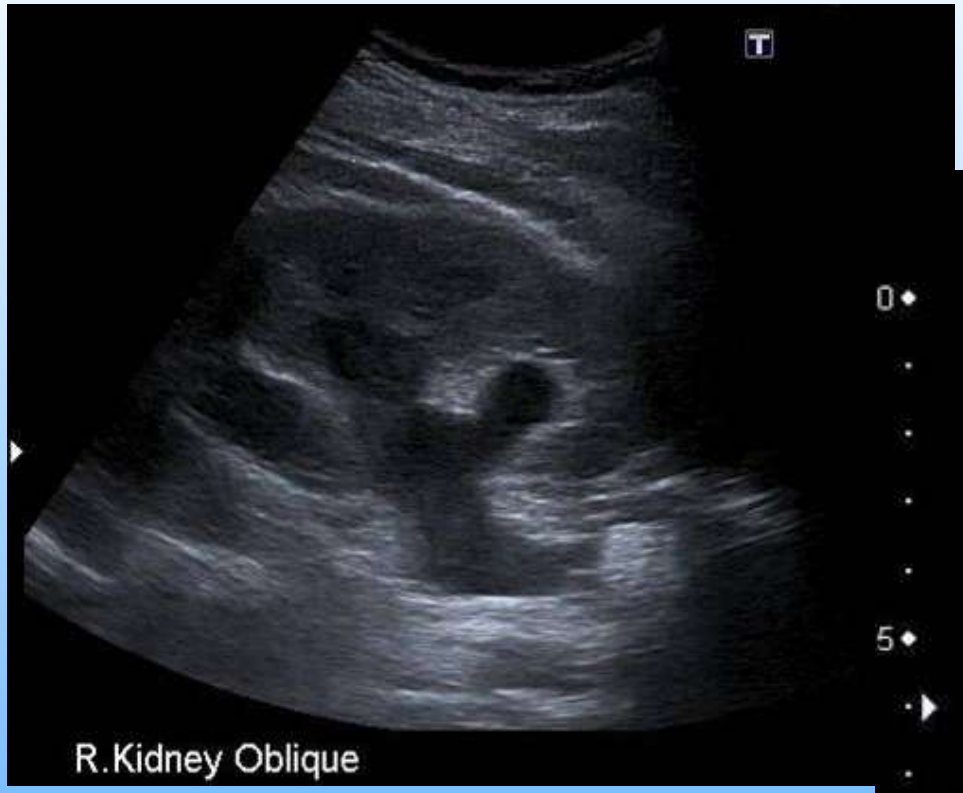
NICE guideline NG 148 (Oct 2024)

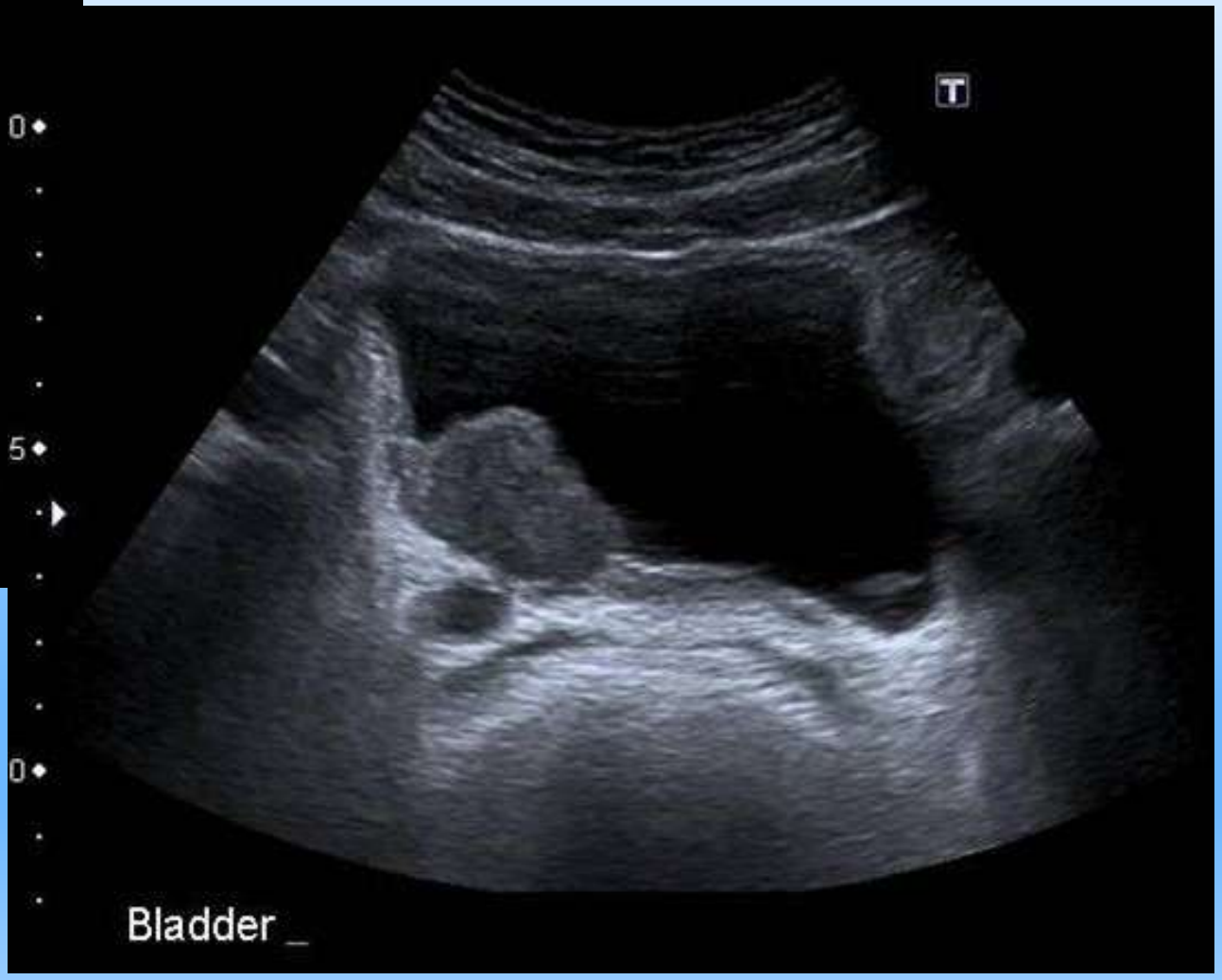
Ultrasound

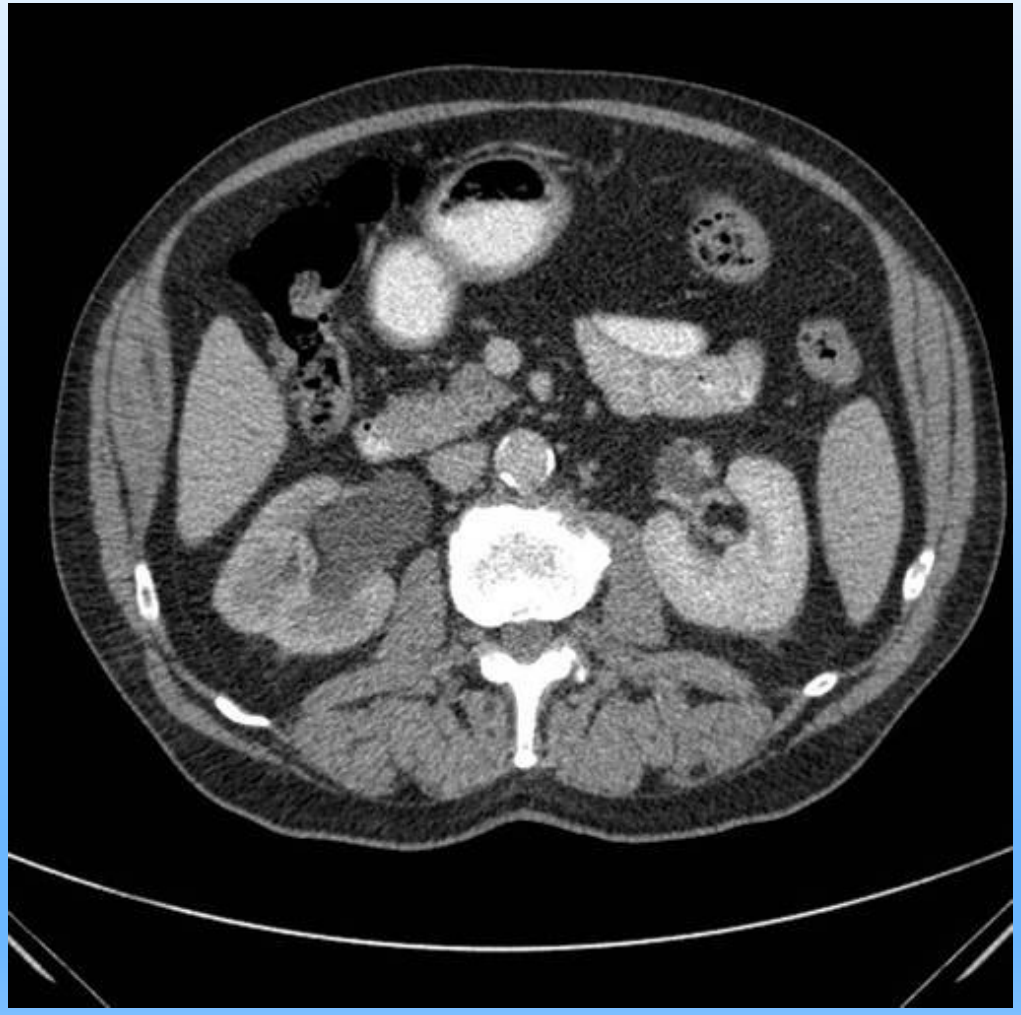
- When adults, children and young people have no identified cause of their acute kidney injury or are at risk of urinary tract obstruction, offer urgent ultrasound of the urinary tract (to be performed within 24 hours of assessment)

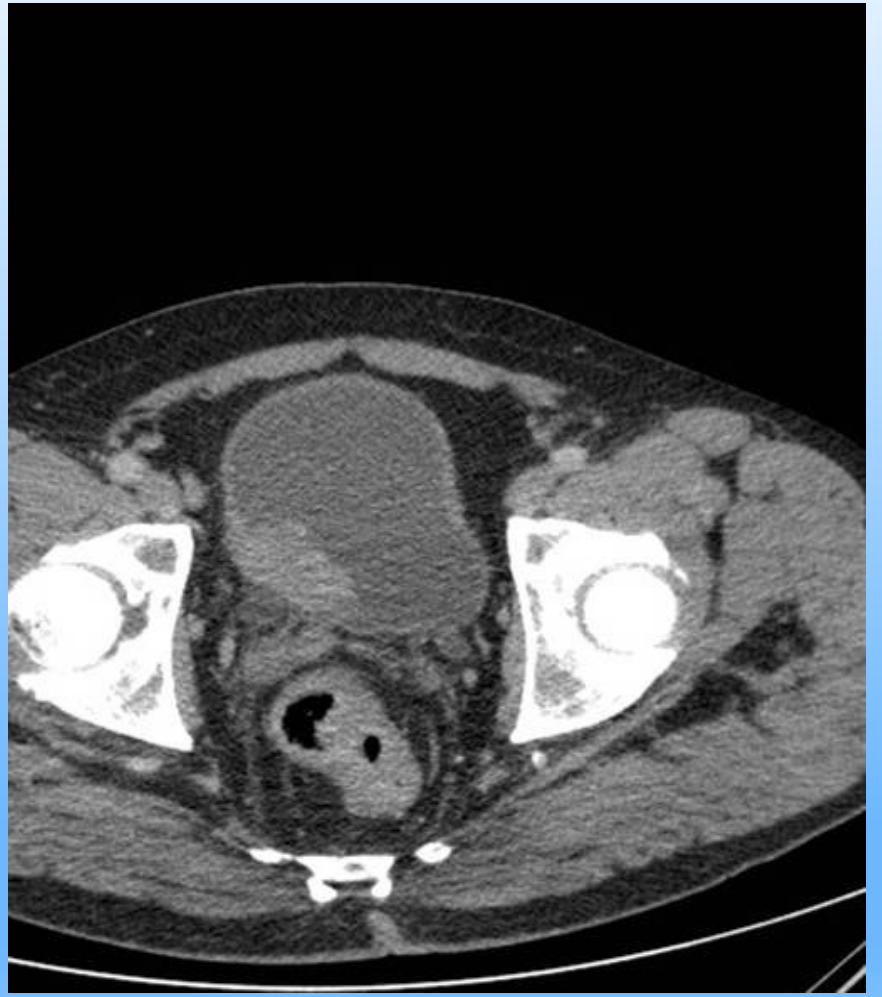

L.Kidney Oblique

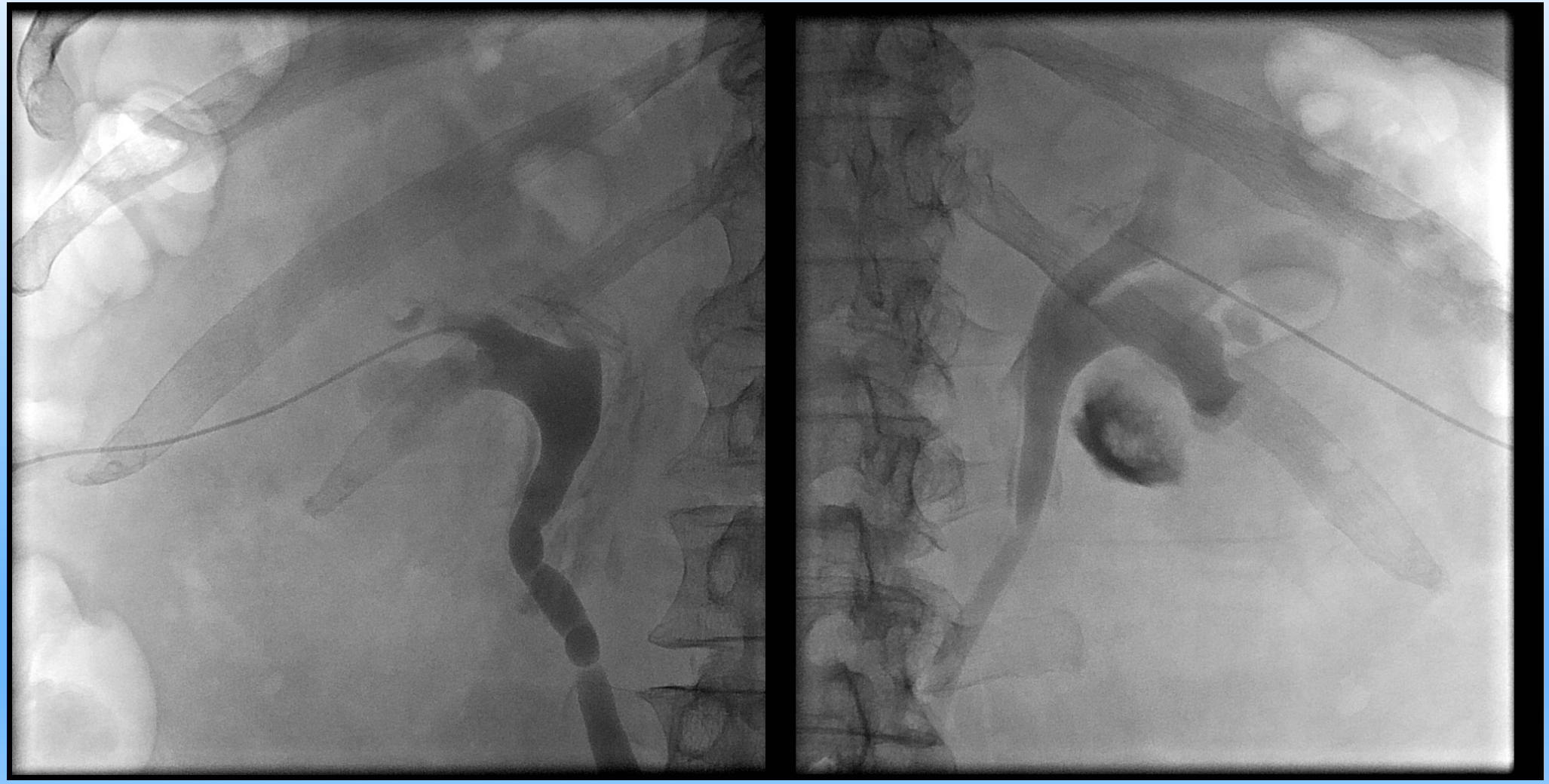

R.Kidney Oblique


R.Kidney Oblique


0
5
0
Bladder _





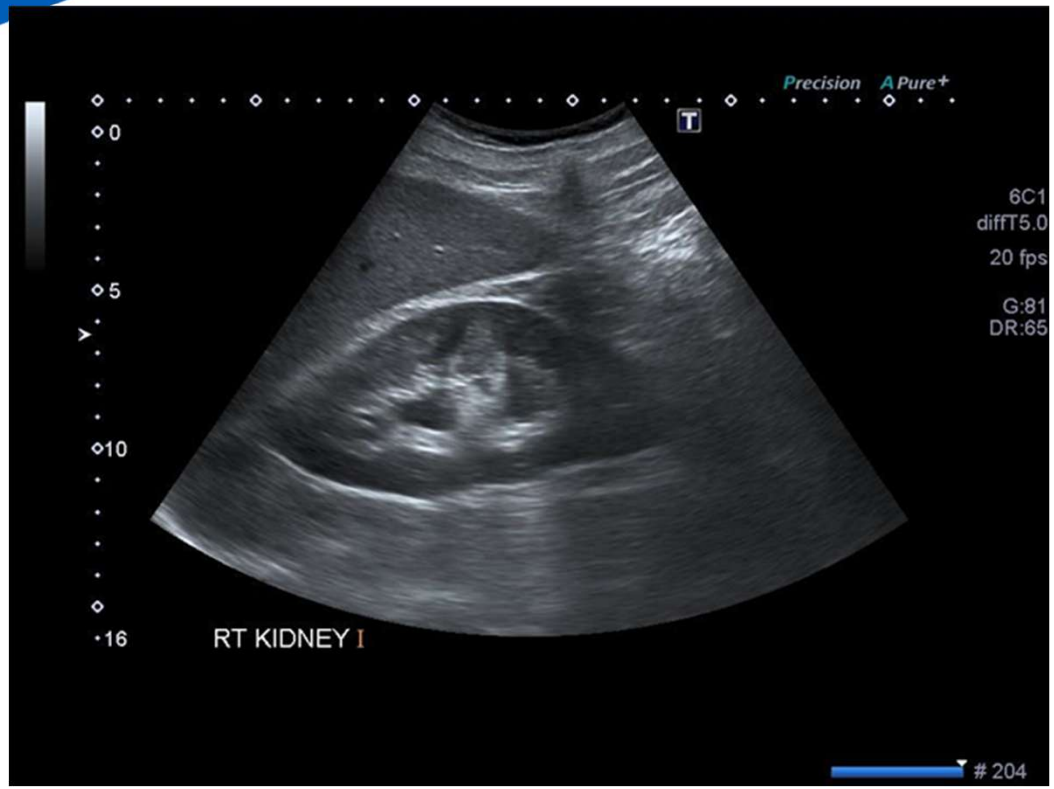


AKI: Prognosis

- 20-30% inpatient mortality
- Indicators of poor prognosis include older age, multiple organ failure, oliguria, hypotension, number of transfusions and acute on chronic renal failure.
- Prognosis is closely related to the underlying cause.
- Patients who need dialysis have a higher mortality

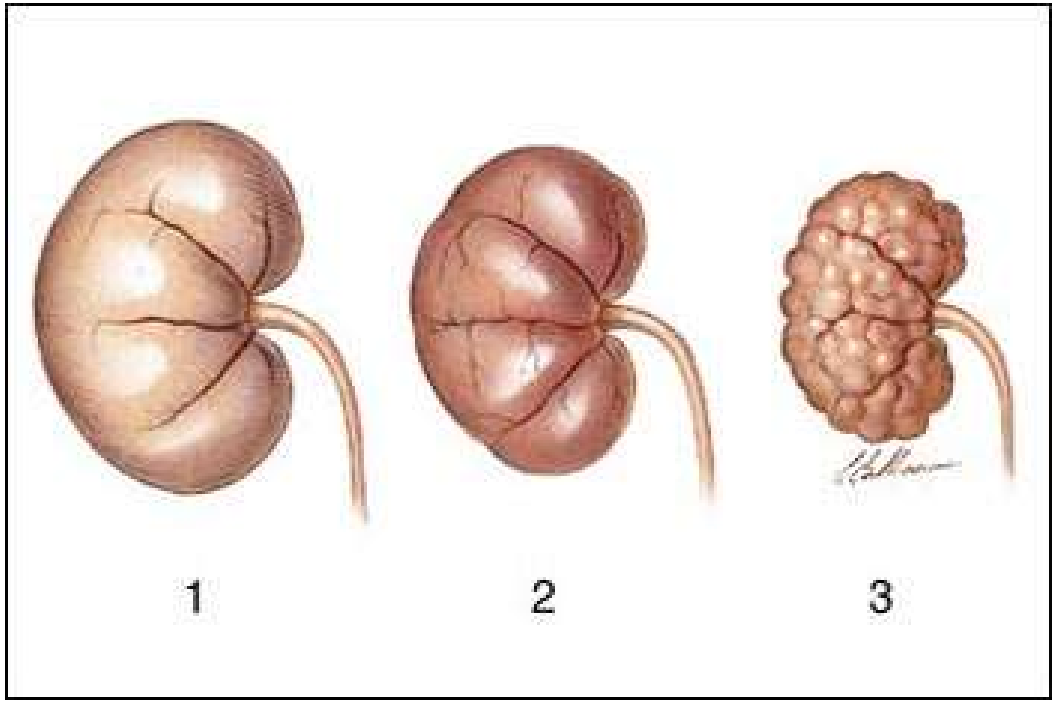
AKI: Ultrasound

- Although the rate of abnormal ultrasound findings in the setting of AKI is not high (about 10%), these findings can have a significant impact on patient management



AKI: Ultrasound

- Renal size and cortical echogenicity
  - Normal range 9 – 10.5am
  - = / Hypoechoic to Liver
- Large (AKI) vs Small (CRF)
- Cortical Thickness / preservation
  - Normal range >1cm
- Thick (AKI) vs Thin (CRF)

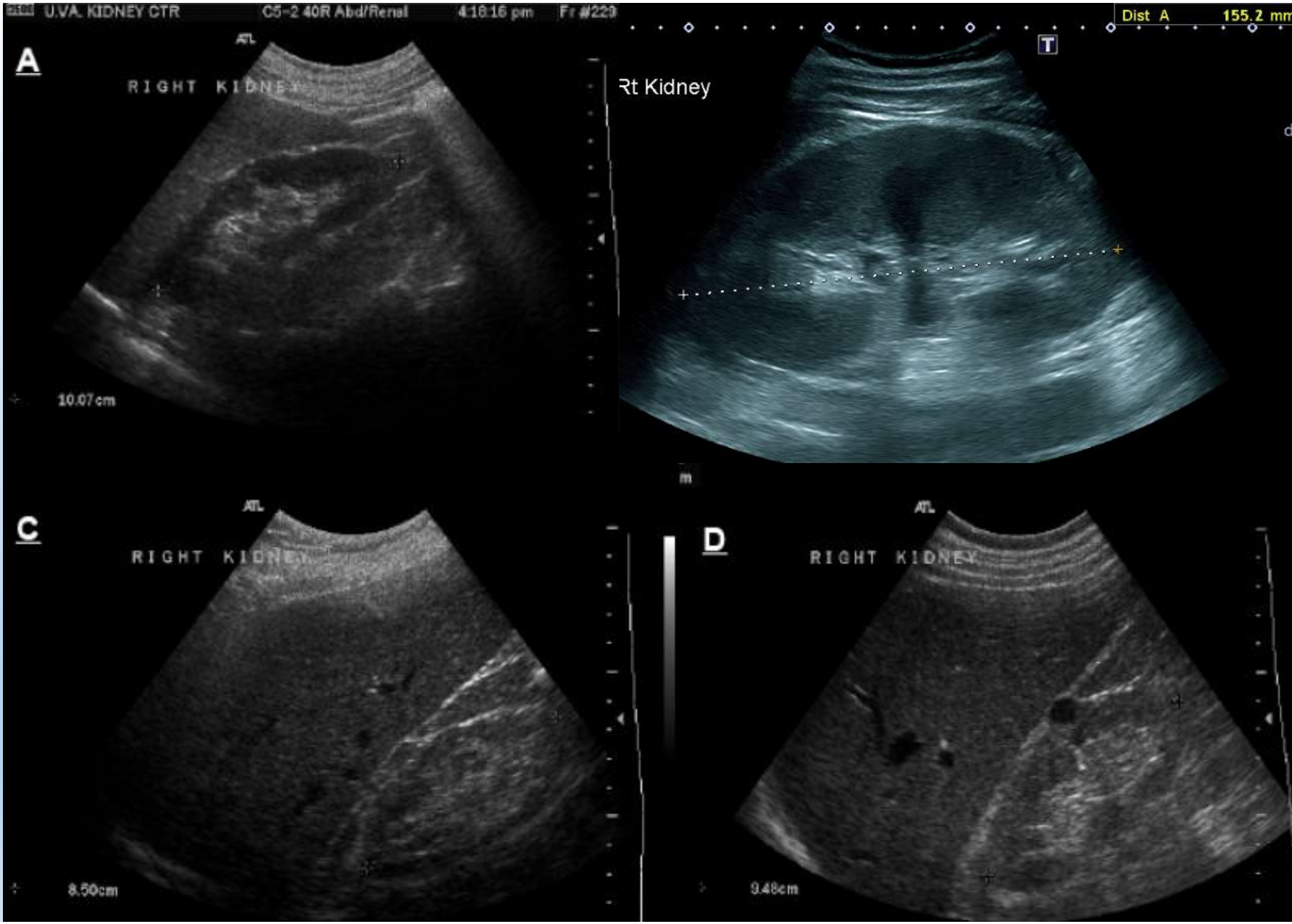


A: Normal

B: AKI

C: CRF

D: NFA / Mild CRF



AKI: Treatment

- The best "treatment" of acute kidney injury (AKI) is prevention.
- Timely identification of AKI and underlying cause required.
- Ultrasound scan should not be delayed
- USS should identify or exclude obstruction
- USS recognise acute vs chronic RF

AKI: Treatment NICE NG148

- Refer all adults, children and young people with upper tract urological obstruction to a urologist. Refer immediately when one or more of the following is present:
- pyonephrosis
- an obstructed solitary kidney
- bilateral upper urinary tract obstruction
- acute kidney injury caused by urological obstruction.
- when nephrostomy or stenting is used to treat upper tract urological obstruction in adults, children and young people with acute kidney injury, undertake as soon as possible and within 12 hours of diagnosis.

Can we do more?

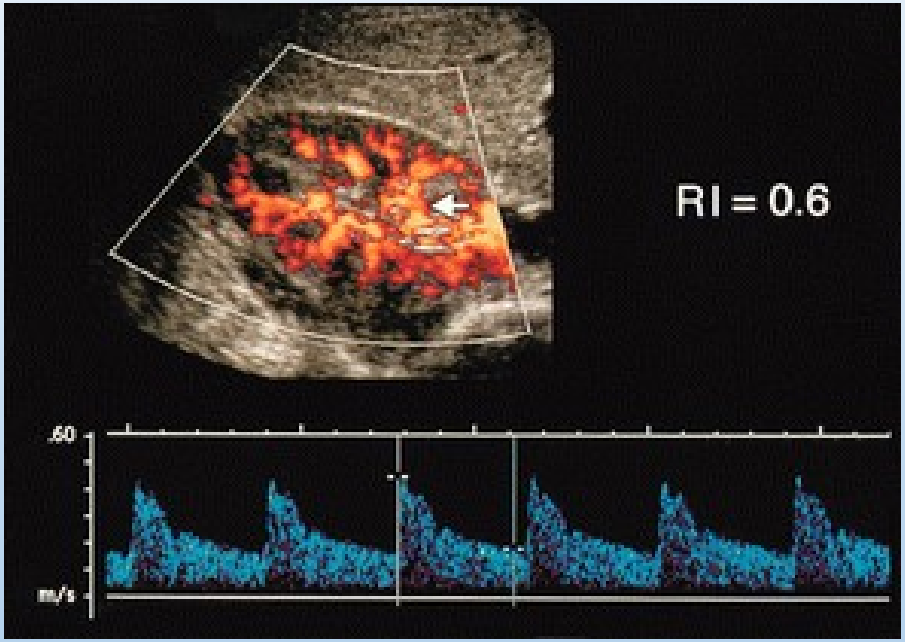
- In the early 1990s, several groups postulated that the pathophysiology of urinary obstruction might be reliably manifested by changes in arterial Doppler spectra
- Haemodynamic response obstruction
- Renal blood flow decreases, and renal vascular resistance increases

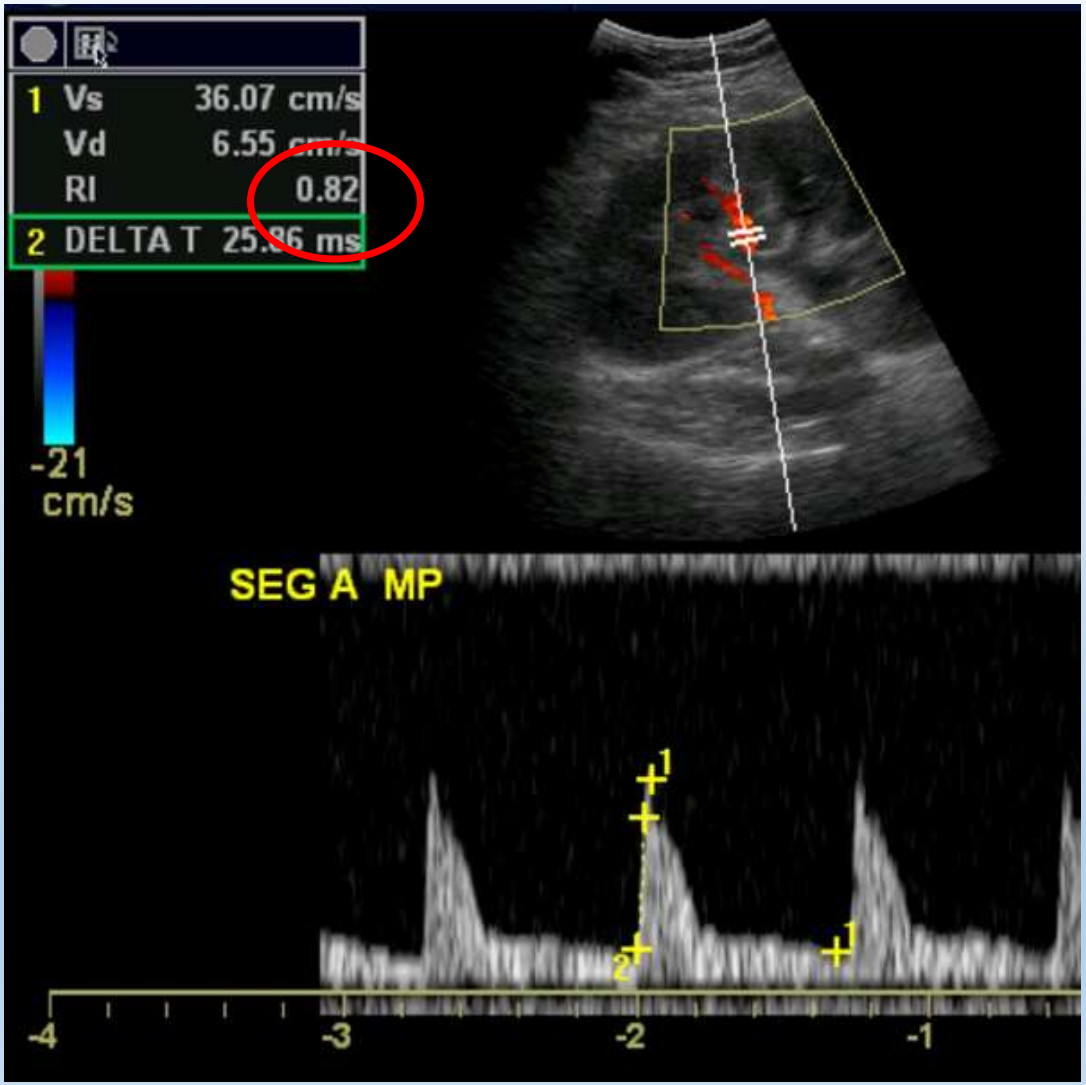
Resistive Index

- This vasoconstriction response is an ideal phenomenon to be detected by changes in the RI
- RI can be increased by extrinsic factors such as kidney compression, breath holding during the Valsalva manoeuver and extreme bradycardia
- RI values are also correlated with arterio-vascular disease (check if bilateral)

Resistive Index in AKI

- RI greater than 0.70 or a difference of greater than 0.06–0.10 in mean RI values between kidneys is found to be highly specific and sensitive for acute obstruction
- Evidence of obstruction identified before the development of collecting system dilatation with the use of RI values


RI = 0.6
60
m/s


1 Vs 36.07 cm/s
Vd 6.55
RI 0.82
2 DELTA T 25.86 ms
-21
cm/s
SEG A MP
-4
-3
-2
-1

Platt J, Rubin J, Ellis J. Distinction between obstructive and nonobstructive pyelocaliectasis duplex Doppler sonography. *AJR* 1989; 153:997 –1000

A larger study of 229 kidneys. In this study, a discriminatory RI threshold of 0.70 was used; the sensitivity and specificity of the Doppler diagnosis of obstruction were 92% and 88%, respectively. Moreover, the accuracy of the Doppler diagnosis of obstruction increased when the RI of the potentially obstructed kidney was compared with that of the unaffected contralateral kidney.

An RI difference greater than 0.10 between kidneys was seen only with true obstruction.

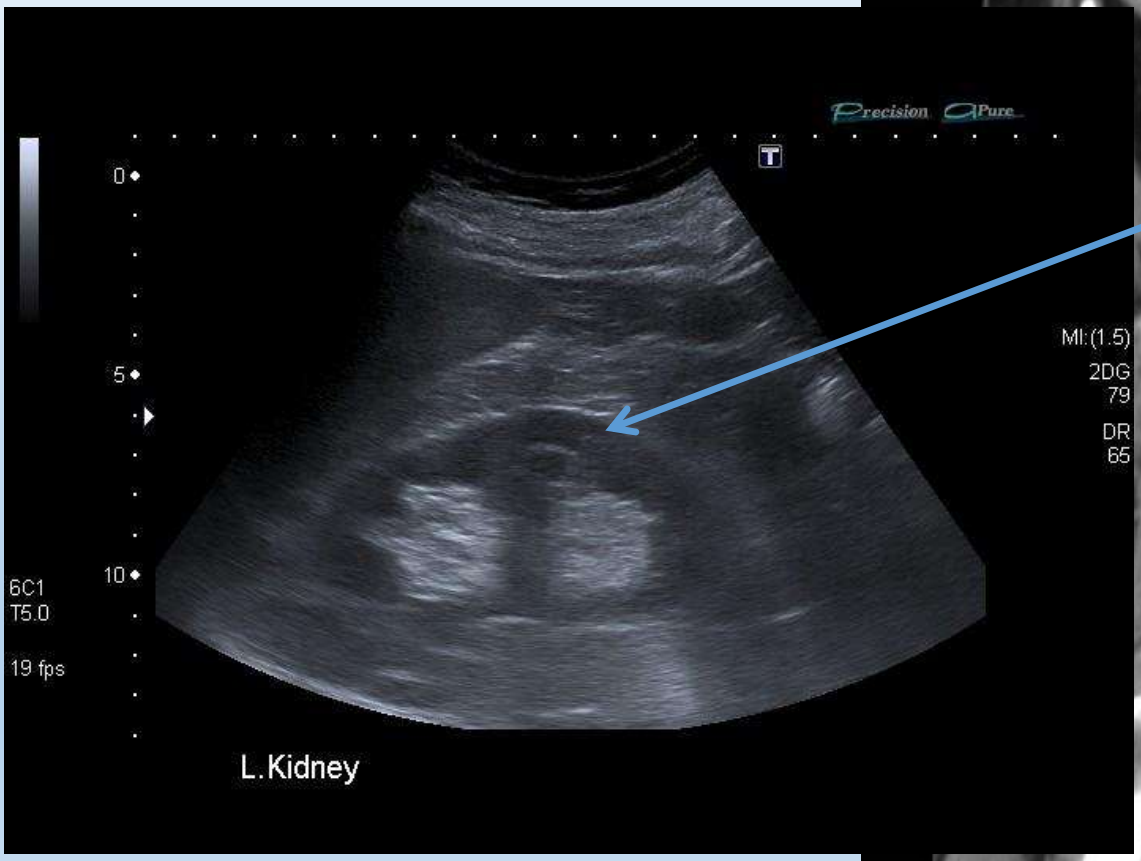
Chen J, Pu Y, Liu S, Chin TY. Renal hemodynamics in patients with obstructive uropathy evaluated by duplex Doppler sonography. *J Urol* 1993

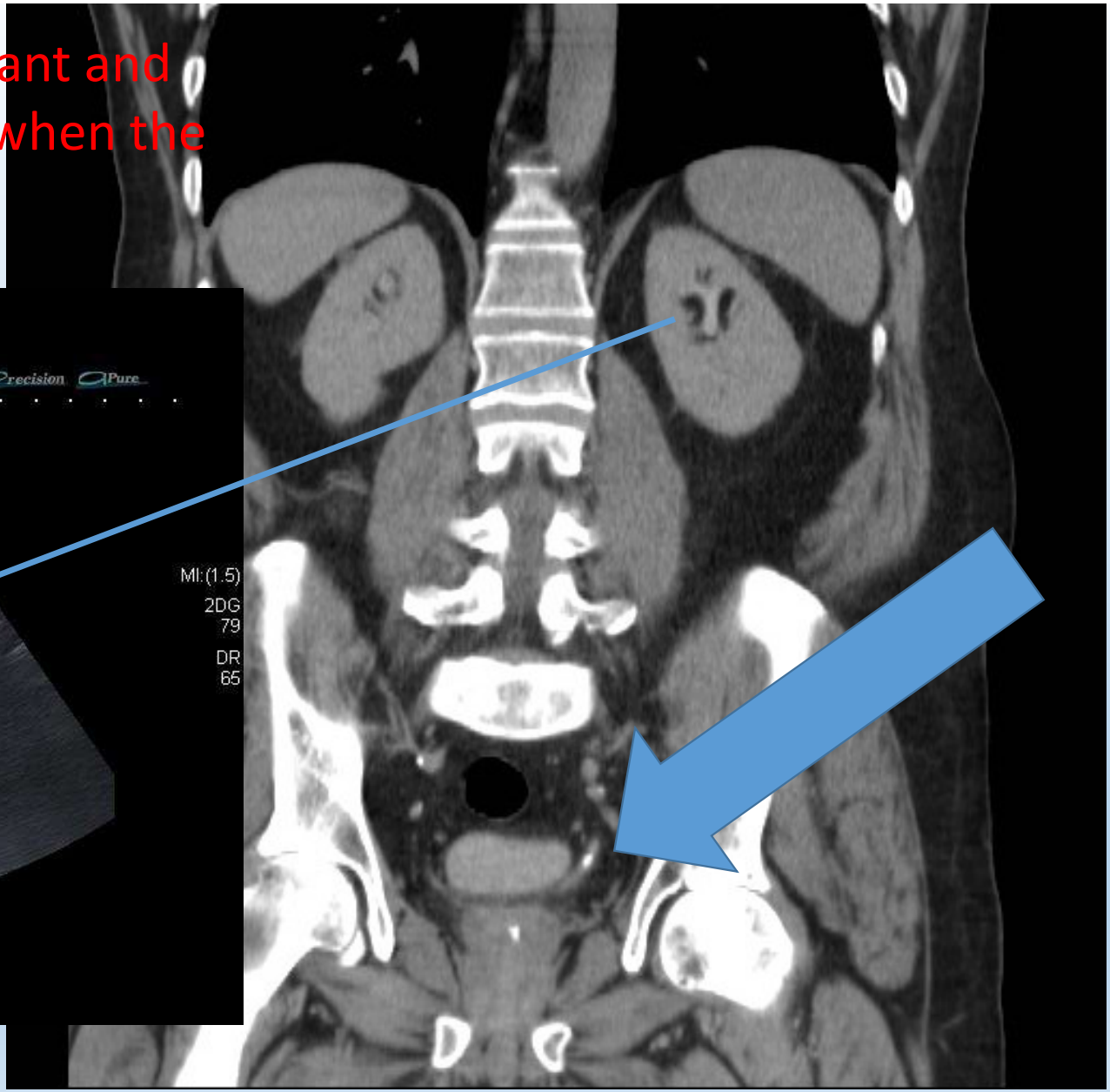
Evaluated 56 kidneys in 28 normal subjects and 53 kidneys in 27 patients with unilateral or bilateral obstructive uropathy.

The mean resistive index values for mildly and significantly obstructed kidneys were 0.64 +/- 0.08 and 0.74 +/- 0.05, respectively. More than 93.3% of the **significantly obstructed kidneys had resistive index values greater than or equal to 0.70.**

The obstruction may be significant and demands surgical intervention when the resistive index reaches that value. In contrast, with resistive index values of less than 0.70 renovascular resistance is minimally altered and obstruction may be mild.

The obstruction may be significant and demands surgical intervention when the resistive index reaches 0.7





Platt J, Rubin J, Ellis J. Acute renal obstruction: evaluation with intrarenal duplex Doppler and conventional US. *Radiology* 1993; 186:685 –688

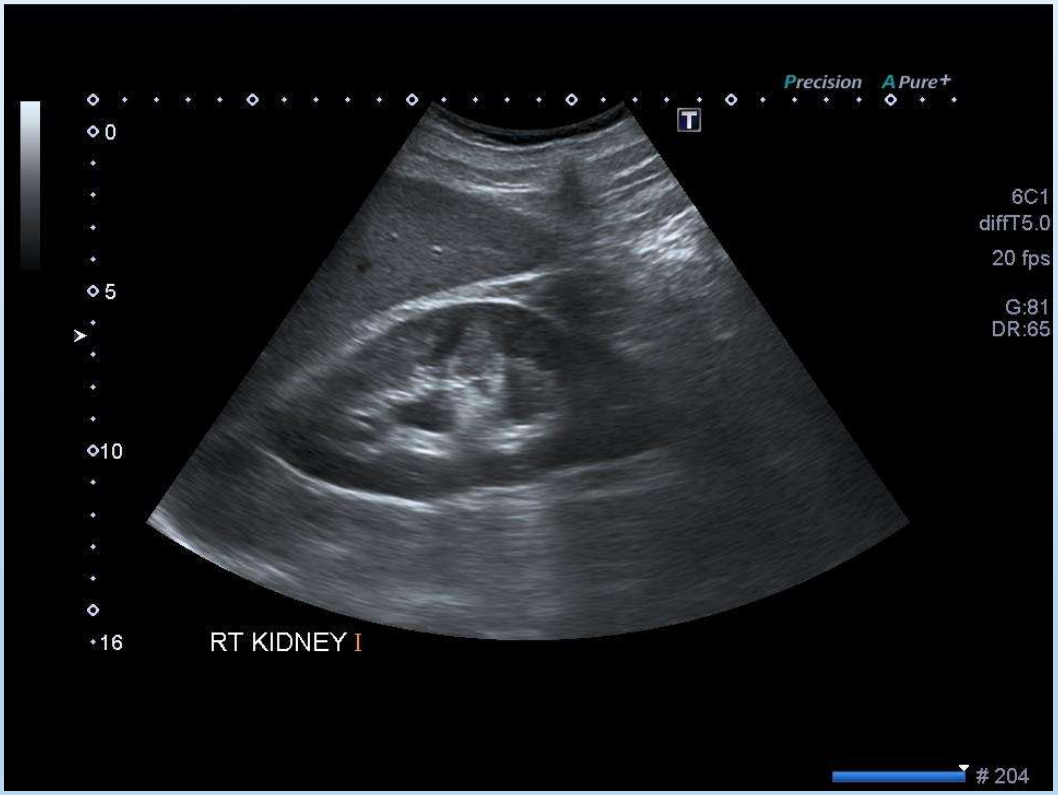
To evaluate duplex Doppler ultrasound (US) in acute renal obstruction, bilateral intrarenal Doppler US was performed in 23 patients with unilateral renal obstruction (proved by means of intravenous urography) of 36 hours duration or less. A mean renal resistive index (RI) was calculated for each obstructed and normal contralateral kidney and compared with findings on conventional US scans. The mean RI in the obstructed kidneys was elevated (.77 +/- .07 [standard deviation]) and was higher than the mean RI in the normal contralateral kidney (.60 +/- .04) ($P < .001$). RIs in the obstructed kidneys were as follows: .75 or greater in 15 kidneys, .70-.74 (mild RI elevation) in five kidneys (but > or = .10 higher than the RI in the normal contralateral kidney), and less than .70 in three kidneys (two of these three patients had pyelosinus extravasation and one patient had clinical obstruction for only 4-5 hours). **RI elevation occurred before collecting-system dilatation in four patients (17%).** RI elevation occurs by 6 hours of clinical acute renal obstruction and may precede pyelocaliectasis. Renal duplex Doppler US contributes useful clinical information, especially when US is the first modality used to evaluate acute renal colic.

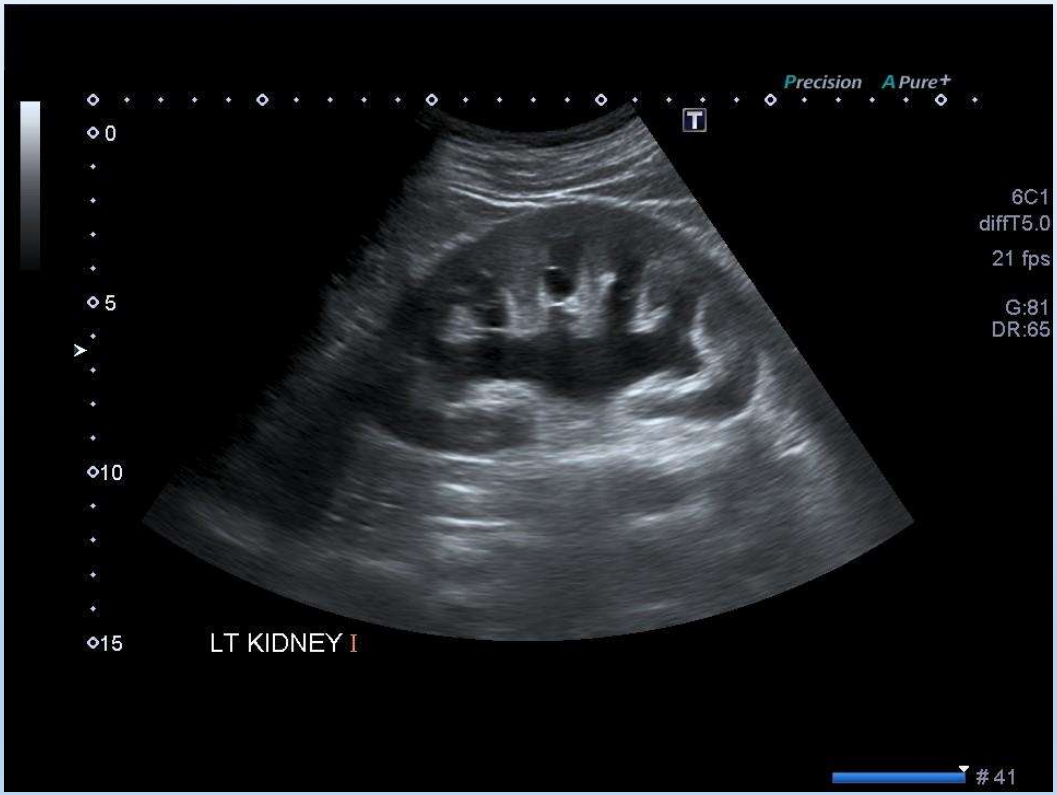
Platt J, Rubin J, Ellis J, DiPietro MA. Duplex Doppler US of the kidney; differentiation of obstructive from nonobstructive dilatation. *Radiology* 1989; 171:515 –517

University of Michigan, RIs from 21 hydronephrotic kidneys were obtained before nephrostomy. The mean RI in 14 kidneys with confirmed obstruction (0.77 ± 0.04) was **significantly higher** than the mean RI from seven kidneys with nonobstructive pelvicaliectasis (0.64 ± 0.04).

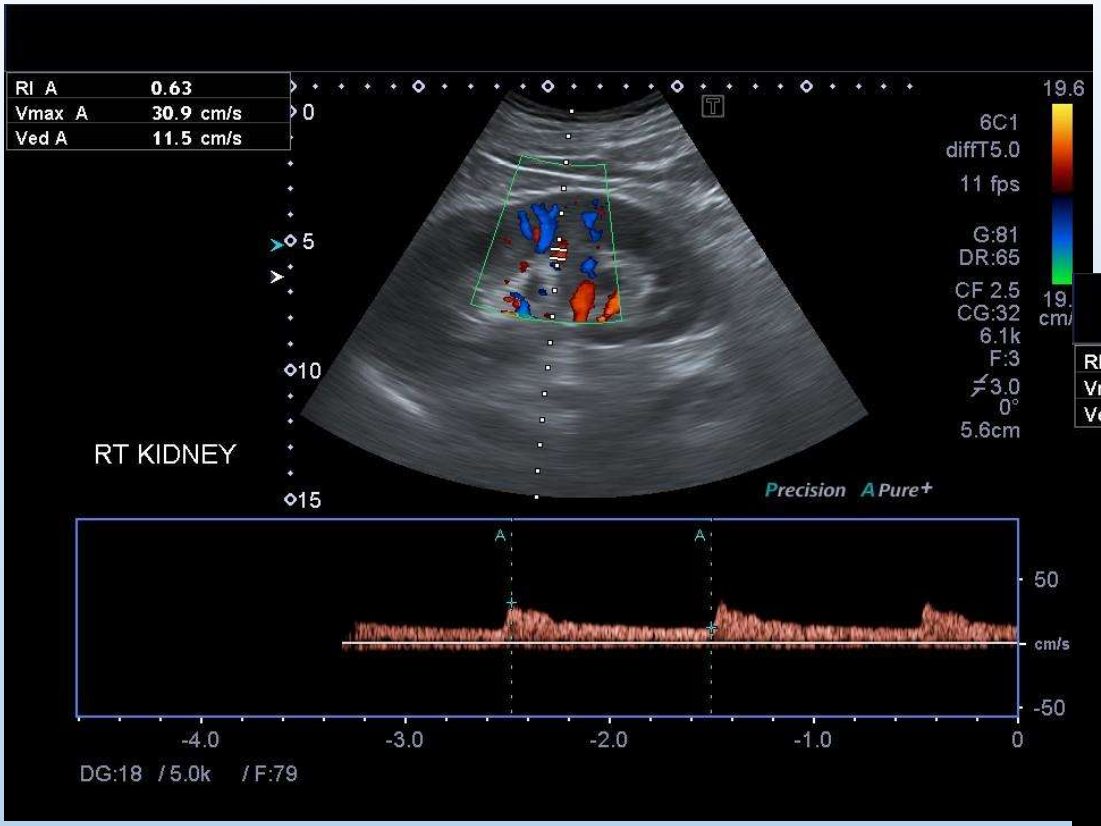
Moreover, **RI values returned to normal after nephrostomy.**

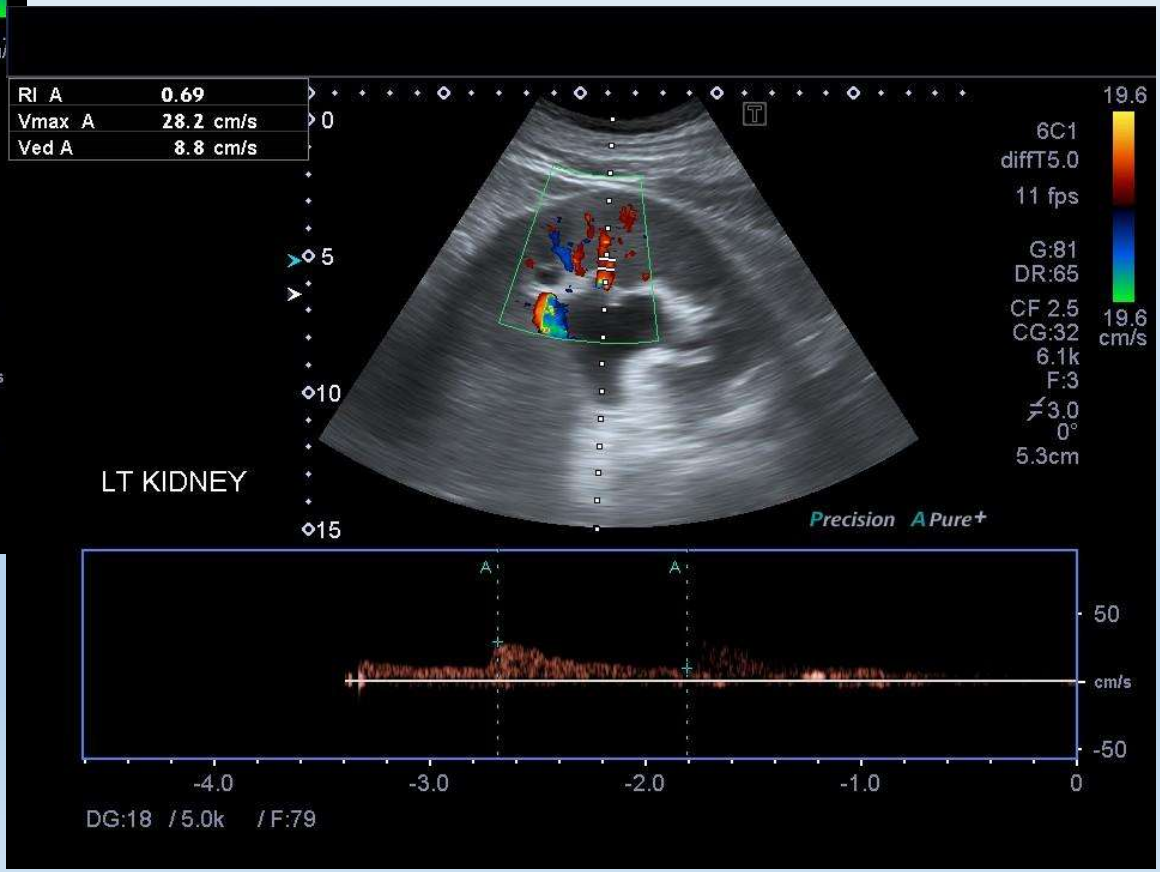
Case 3- AKI


Precision
A Pure+
0
5
10
16
6C1
diffT5.0
20 fps
G:81
DR:65
RT KIDNEY I
204


Precision
A Pure+
0
5
10
15
6C1
diffT5.0
21 fps
G:81
DR:65
LT KIDNEY I
41

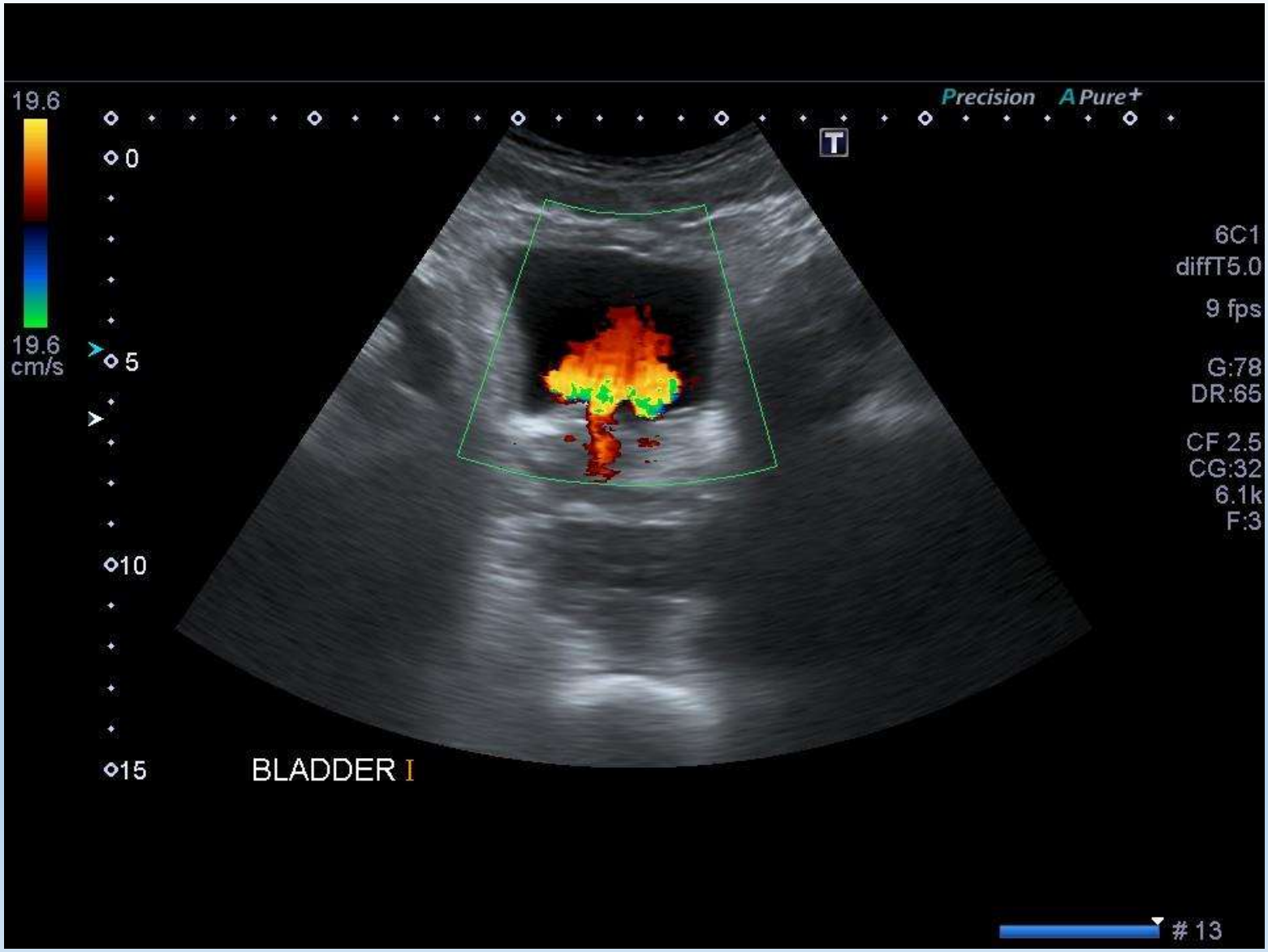
RI: 0.63 & 0.69

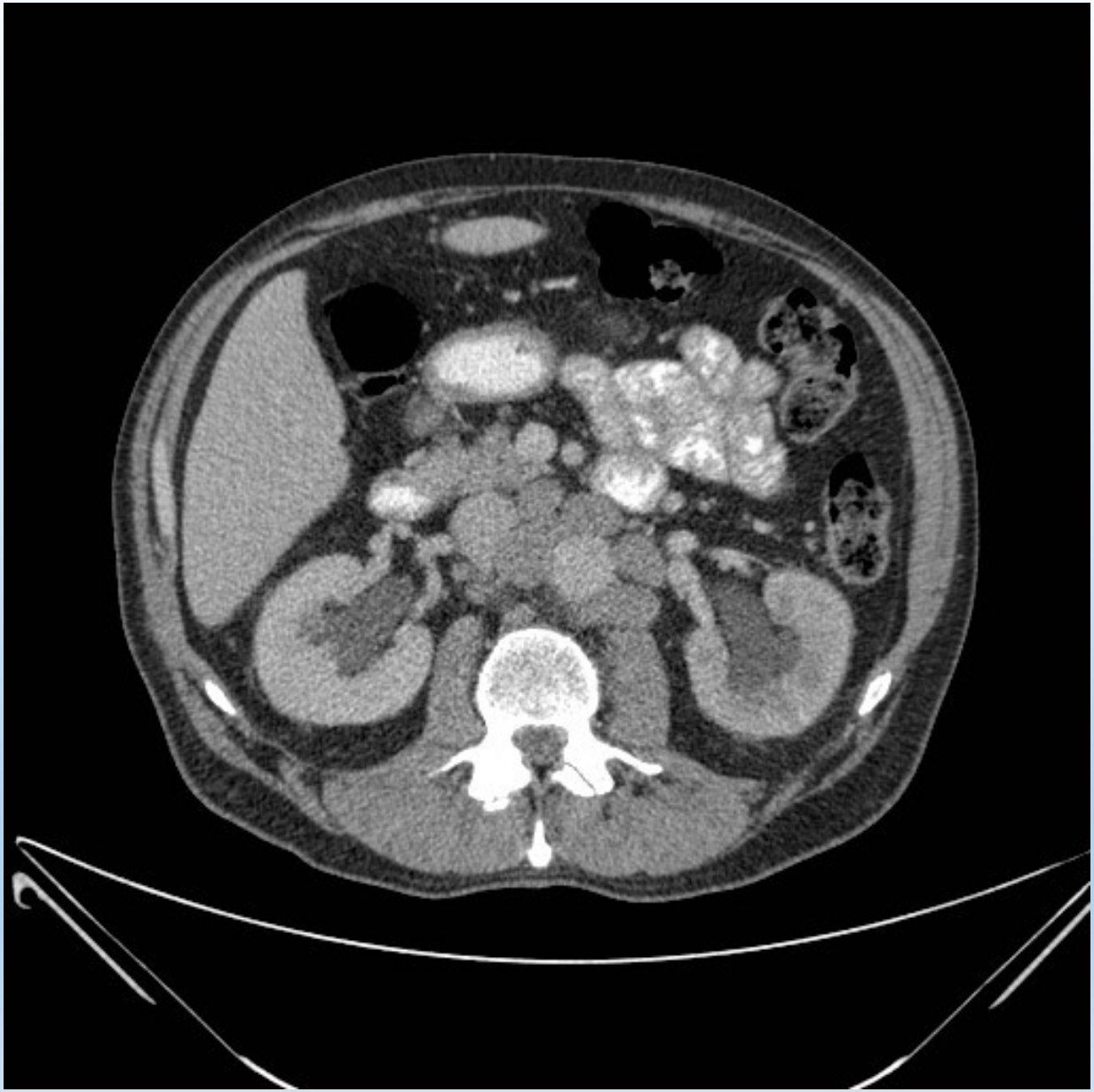

RI A 0.63
Vmax A 30.9 cm/s
Ved A 11.5 cm/s
RT KIDNEY
6C1
diffT5.0
11 fps
G:81
DR:65
CF 2.5
CG:32
6.1k
F:3
3.0
0°
5.6cm
19.6
Precision A Pure+
50
cm/s
-50
-4.0
-3.0
-2.0
-1.0
0
DG:18 / 5.0k / F:79


RI A 0.69
Vmax A 28.2 cm/s
Ved A 8.8 cm/s
LT KIDNEY
6C1
diffT5.0
11 fps
G:81
DR:65
CF 2.5
CG:32
6.1k
F:3
3.0
0°
5.3cm
19.6
19.6 cm/s
Precision A Pure+
50
cm/s
-50
-4.0
-3.0
-2.0
-1.0
0
DG:18 / 5.0k / F:79

Case 3 – What are your thoughts?

A. “I knew RIs were a waste of time”
B. “These RIs must be wrong, I will repeat and alter that Doppler gate…”
C. “I bet Pam’s RIs would be greater than 0.7.”
D. “This may be chronic obstruction in a patient with lymphoma, I will just look to see if there are any ureteric jets, thank goodness I checked the RIs before I advised immediate referral to Urology.”


19.6
19.6
cm/s
0
5
10
15
Precision A Pure+
T
6C1
diffT5.0
9 fps
G:78
DR:65
CF 2.5
CG:32
6.1k
F:3
BLADDER I
13



Diagnostic criteria

Detect acute kidney injury by using any of the following criteria:

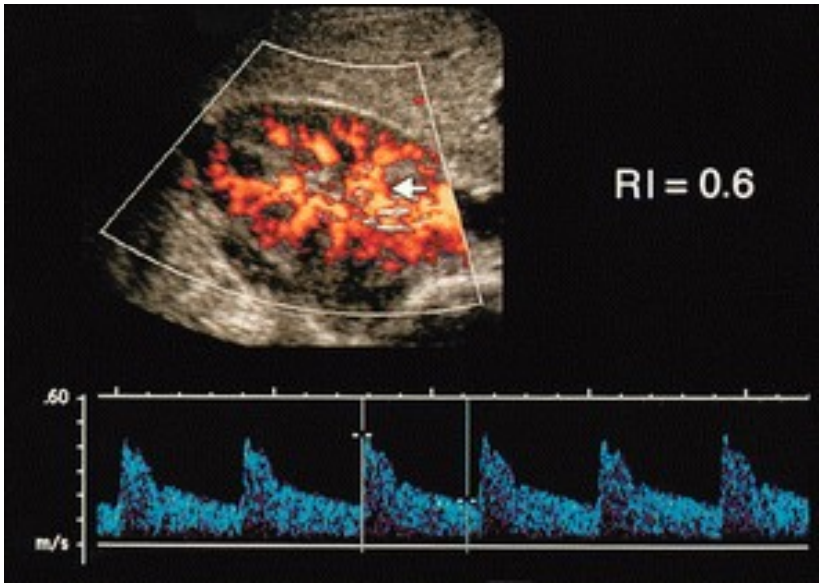
- a rise in serum creatinine of 26 micro mol/l or greater within 48 hours
- a 50% or greater rise in serum creatinine known or presumed to have occurred within the past 7 days
- a fall in urine output to less than 0.5 ml/kg/hour for more than 6 hours in adults and more than 8 hours in children and young people
- a 25% or greater fall in eGFR in children and young people within the past 7 days.

Conclusion

- B-mode provides a valuable assessment of hydronephrosis
- Causes of hydronephrosis should be identified and documented
- Grey scale factors are valuable to differentiate between AKI & CRF
- AP diameter not diagnostic but useful for follow-up

Conclusion

- RI assessment useful tool in differentiating between fullness and obstruction
- In cases of AKI RI's can be an indicator of obstruction prior even in absence of hydronephrosis
- RI = or <0.7 is normal
- Difference > 0.10 between kidneys is significant and raises likelihood of obstruction in the higher RI value kidney



Thank You - Any questions?