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# **Doppler assessment of Liver and Renal Transplants**

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Leeds Children's Hospital**

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# Learning Objectives

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- ▶ Anatomy of the transplanted organ
- ▶ Importance of good accurate doppler technique
- ▶ Vascular complications and their management



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# **Liver TX anatomy & anastomoses**

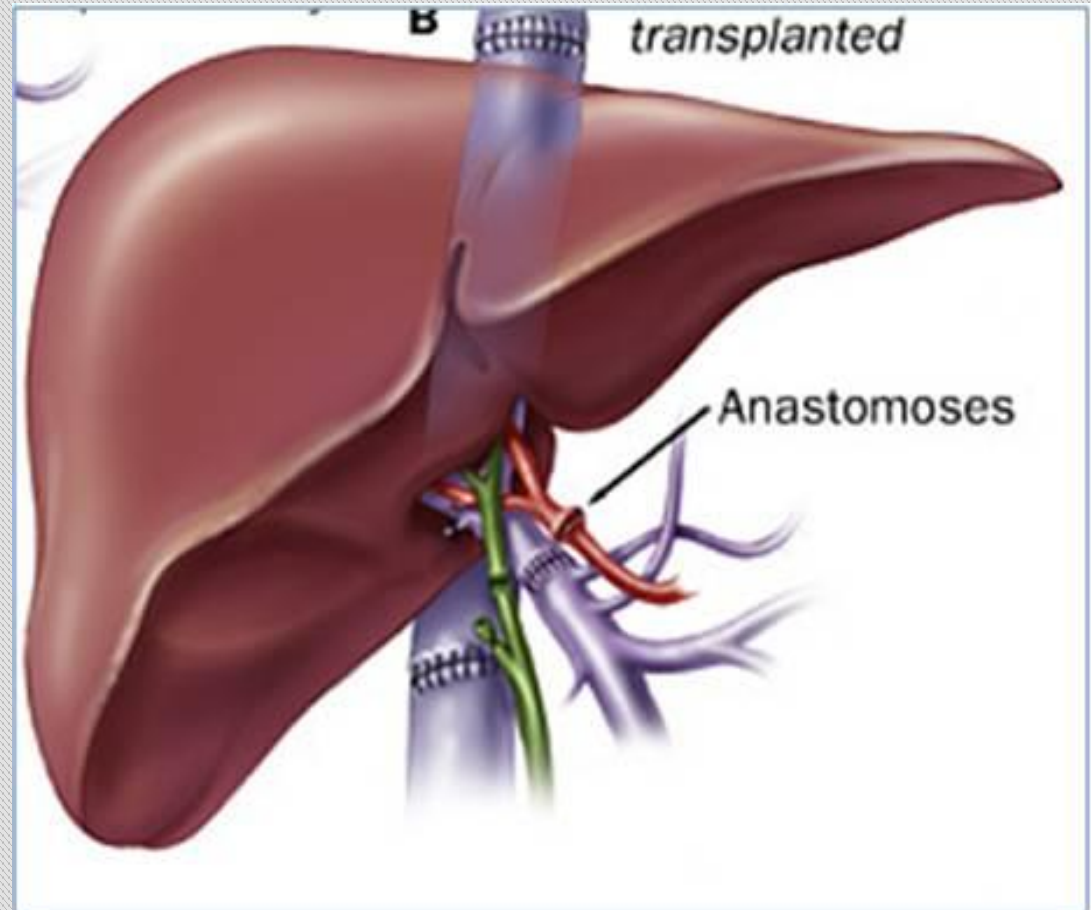


# Liver Tx anatomy & anastomoses

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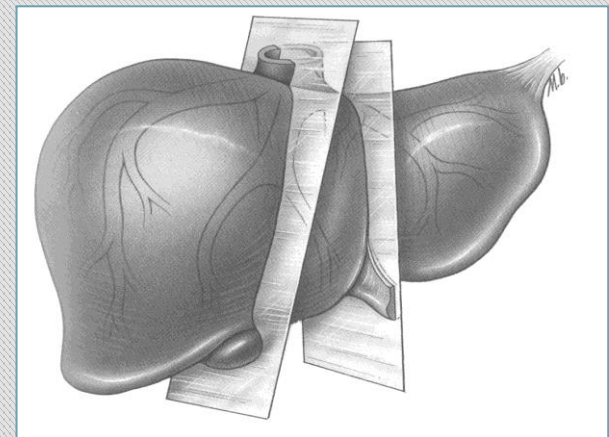
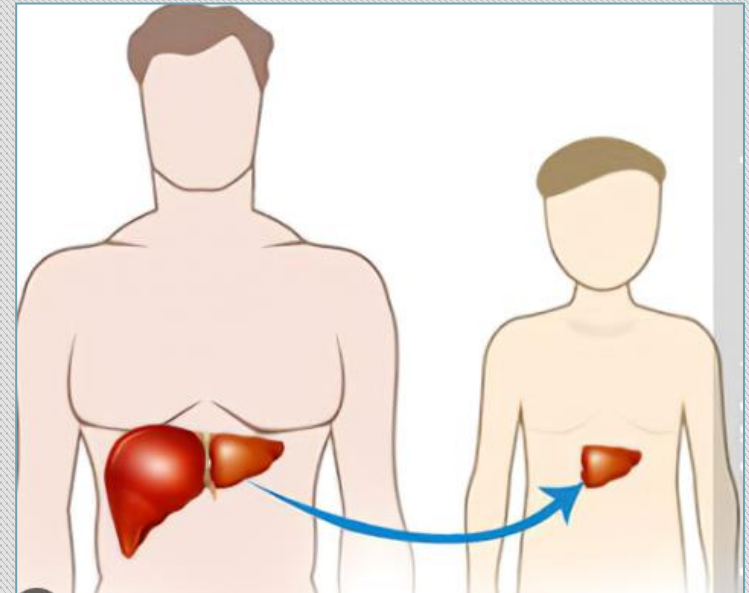
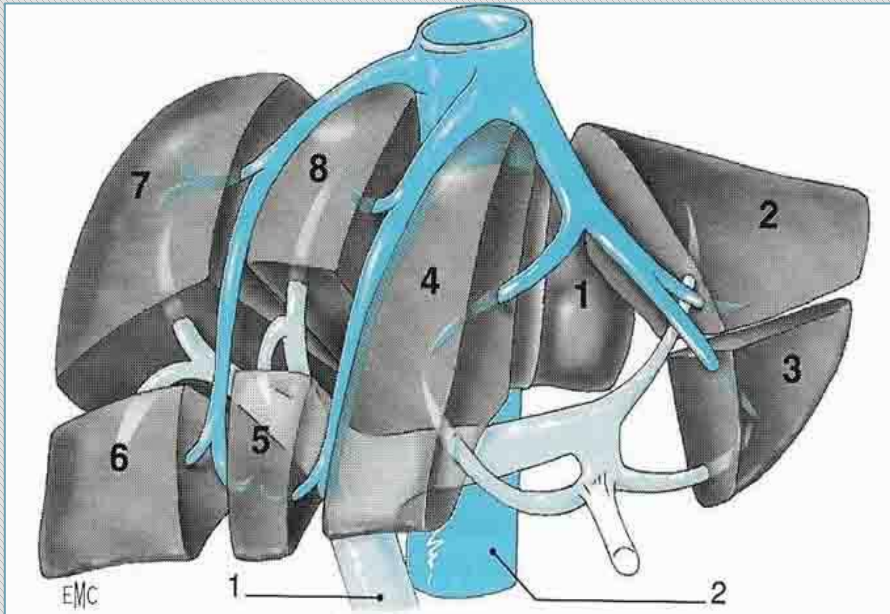
Whole graft –  
Usually adult  
older children

Anastomoses are  
potential problems



# Operative information

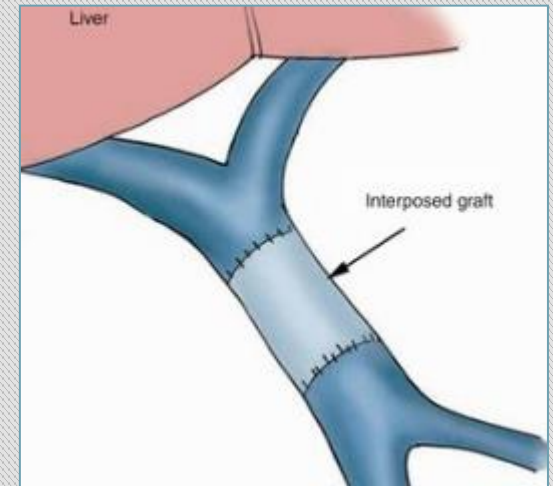
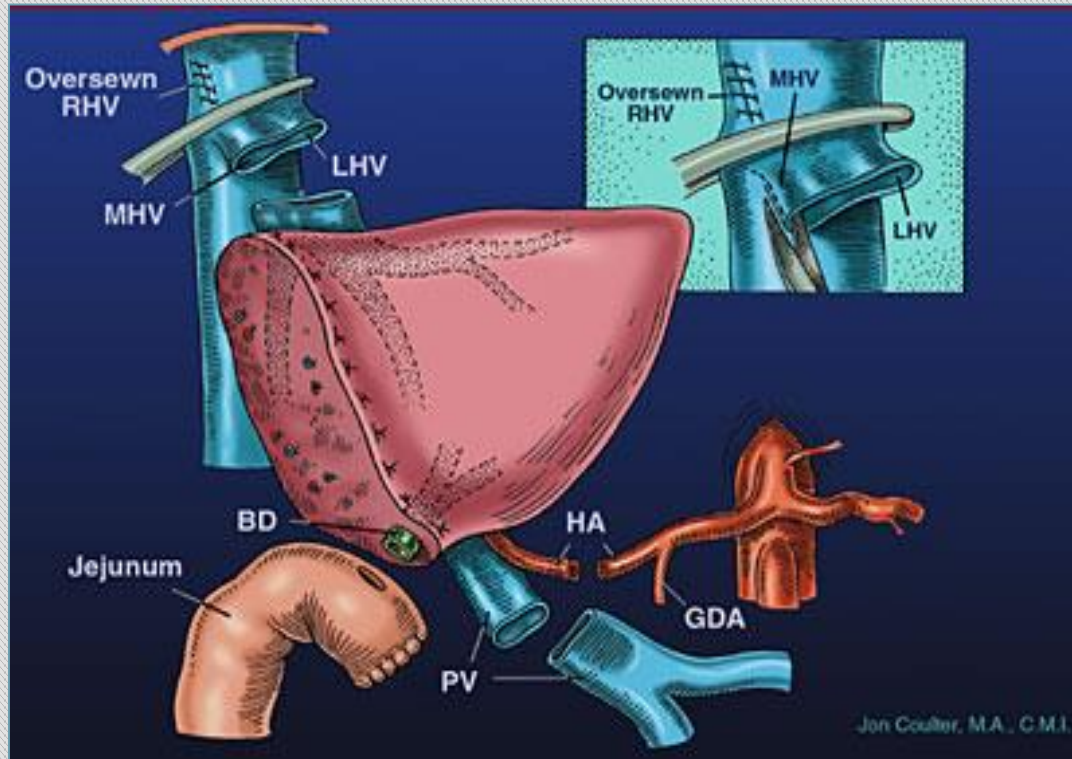
## Split-liver Transplant



Usually use segments 2&3  
Sometimes full lobe split



# Liver Tx anatomy & anastomoses



May have interposed graft

Split liver has increased risk of vascular and biliary complications. Operative knowledge of anastomoses informs potential sites of stricture



# Post Tx ultrasound

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- ▶ Frequency of US is protocol driven in children
  - ▶ scan on days 1,2,3,5,7, 3 months, 1 year & then annually (Leeds)
- ▶ Full abdominal scan to assess:
  - ▶ Non vascular complications: biliary dilatation, collections, ascites
  - ▶ **Vascular complications: assess hepatic artery, portal vein, hepatic veins, IVC, splenic vein for patency and stenosis.**



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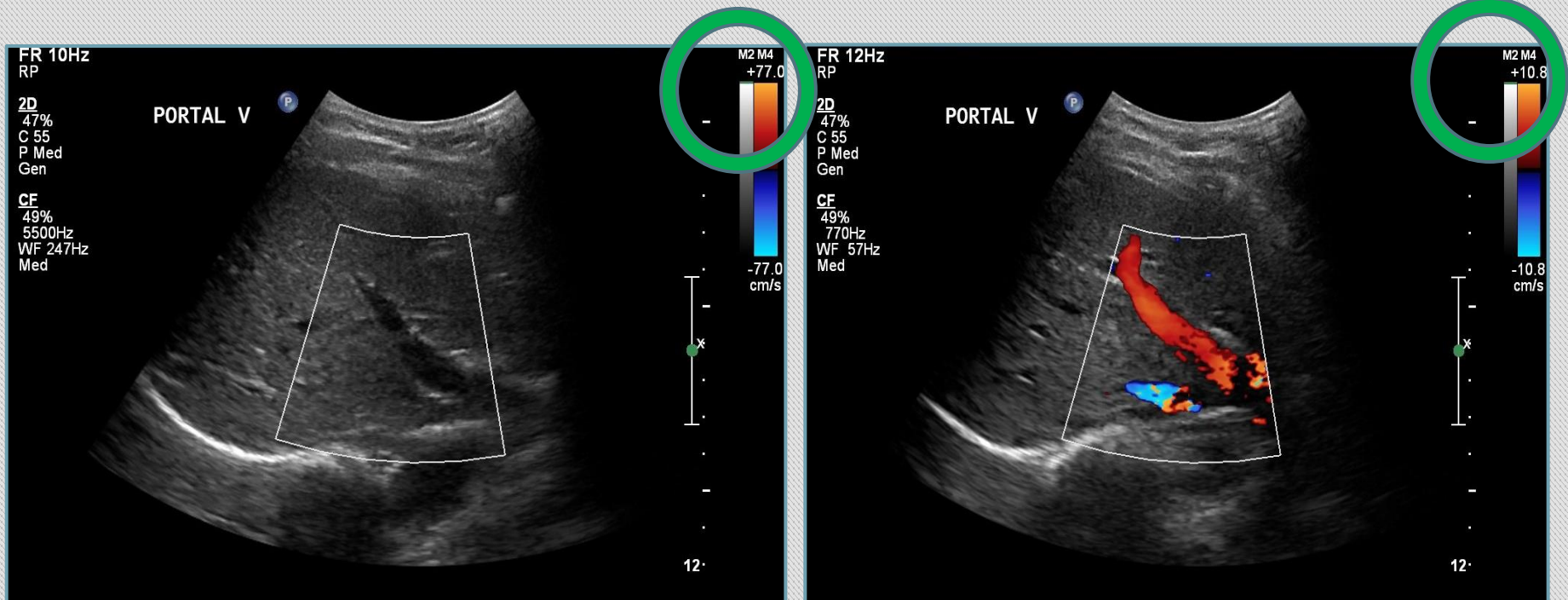
# **Doppler technique revision**





# Doppler technique

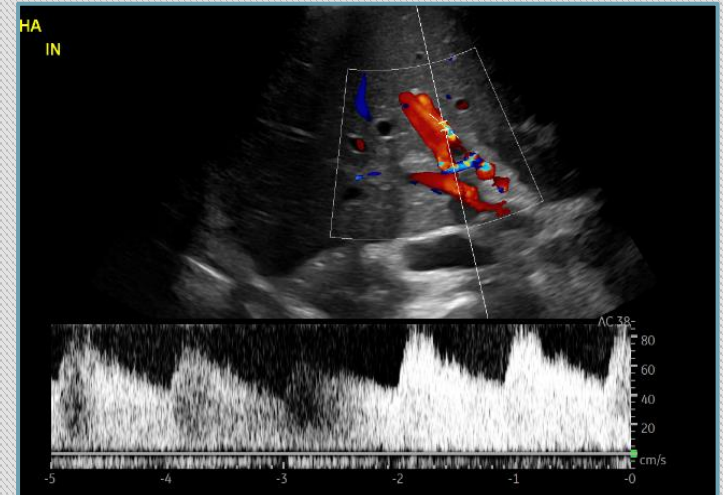
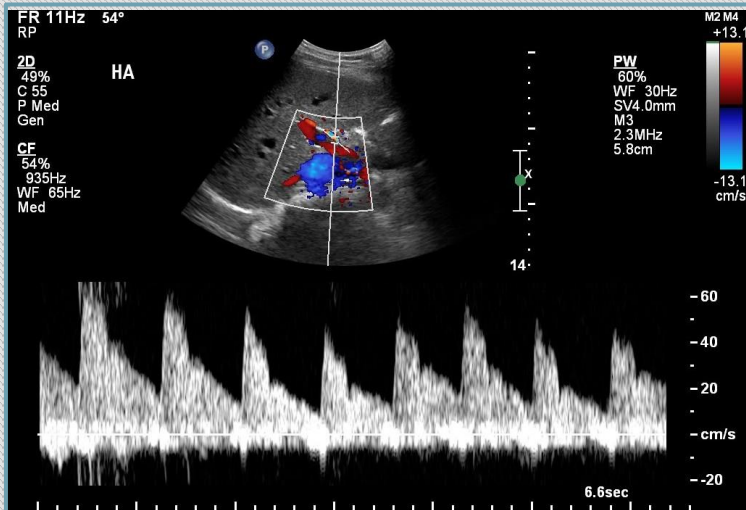
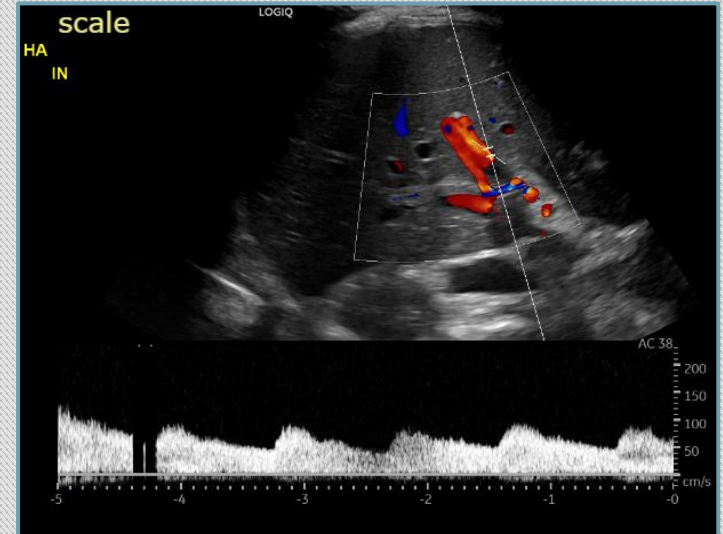
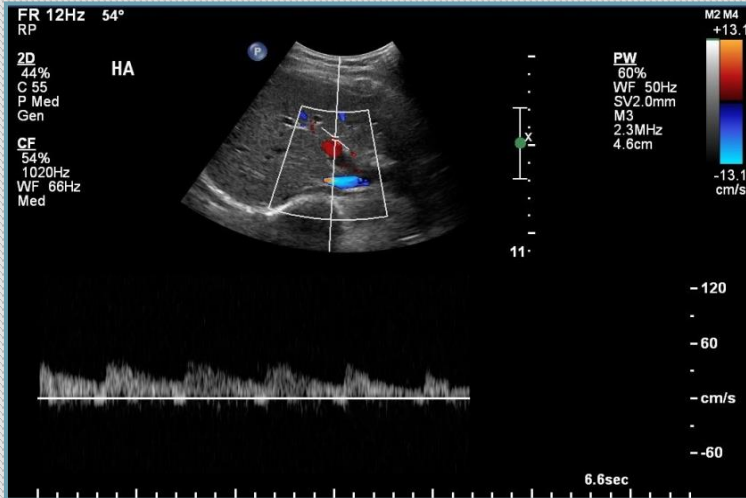
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- Incorrect settings can lead to false positive occlusion: remember colour scale (PRF) and gain
- 



# Doppler technique



- ▶ Use appropriate spectral scale to enable assessment of waveform

# Doppler technique



To measure velocity the angle correct should be  $<60^\circ$  and aligned to the vessel.

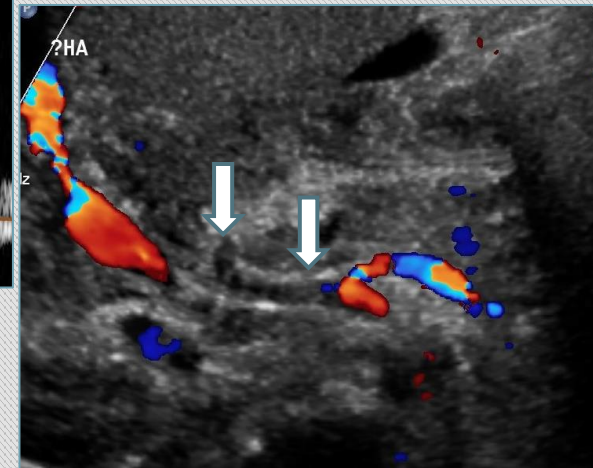
Incorrect angle correction impacts velocity measurement



# Hepatic artery assessment

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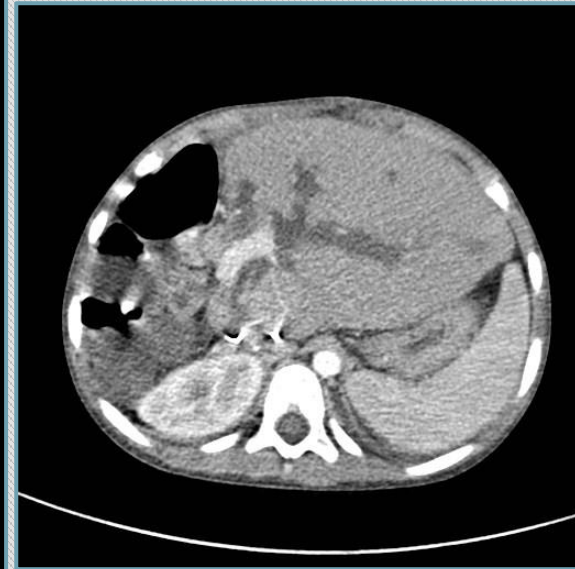
- ▶ Is it patent?
  - ▶ HA is the only blood supply to biliary epithelium in TX liver - patency is vital
- ▶ Occlusion results in ischemia or necrosis
- ▶ US shows absence of HA and intrahepatic arterial flow



Occluded  
HA





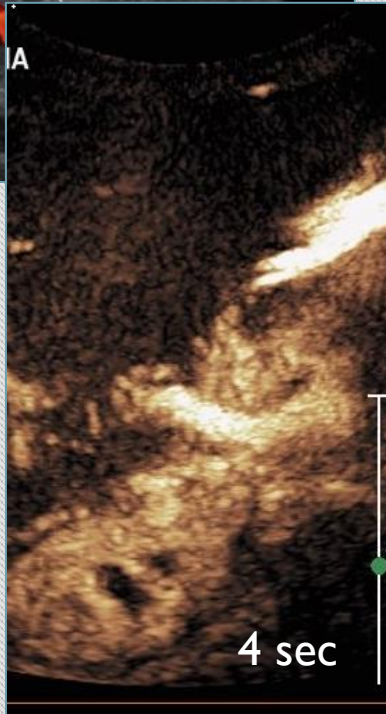
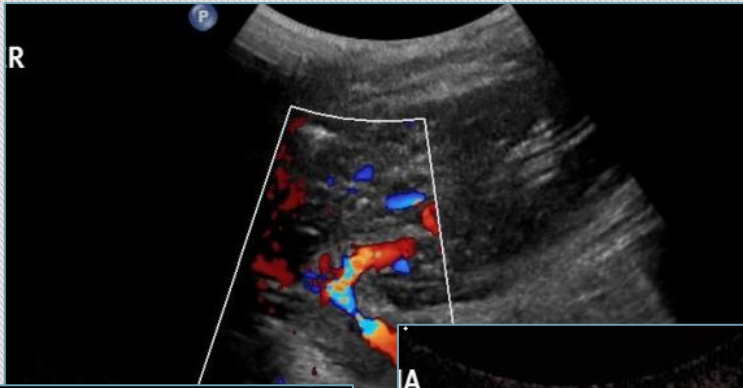


Peri-portal necrosis following HA thrombosis



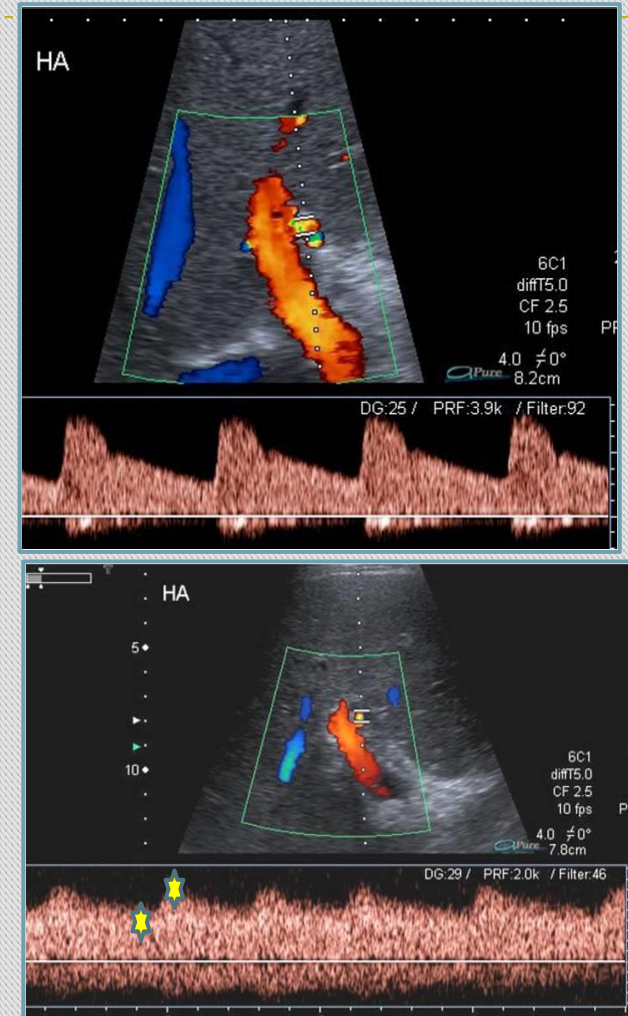
# CEUS

Useful in challenging cases.  
2 yr old Girl Day 1 post  
Liver TX ? HA



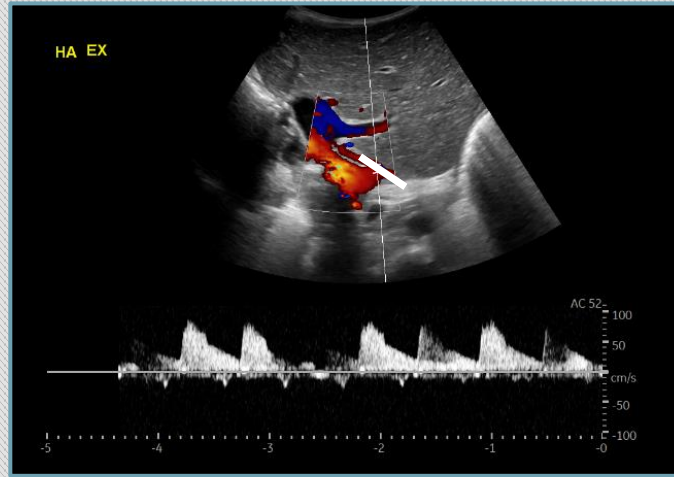
# Hepatic artery stenosis

- HA stenosis – most common vascular complication post transplant
- Intrahepatic waveform distal to stenosis is parvus tardus (sample intrahepatically)
- Parvus Tardus: AI  $>0.08$  sec
- RI  $< 0.5$



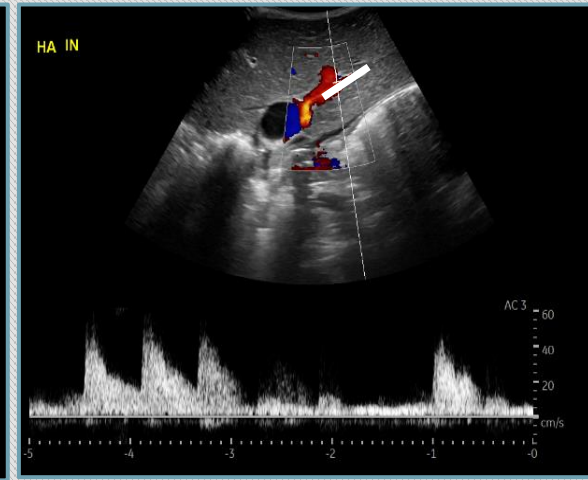
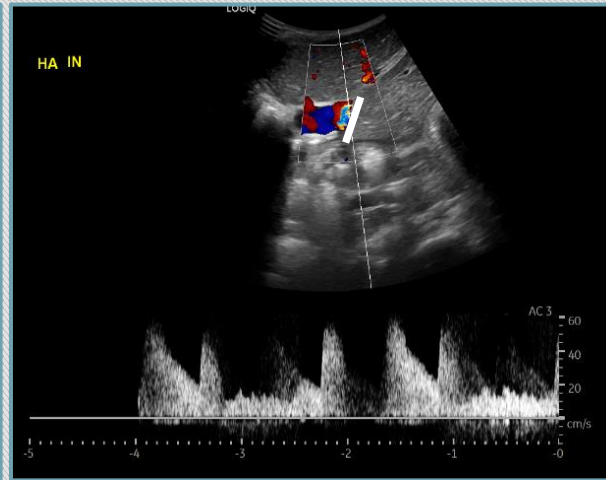


# Hepatic artery assessment



Sample waveform in and out of the liver

Angle correct

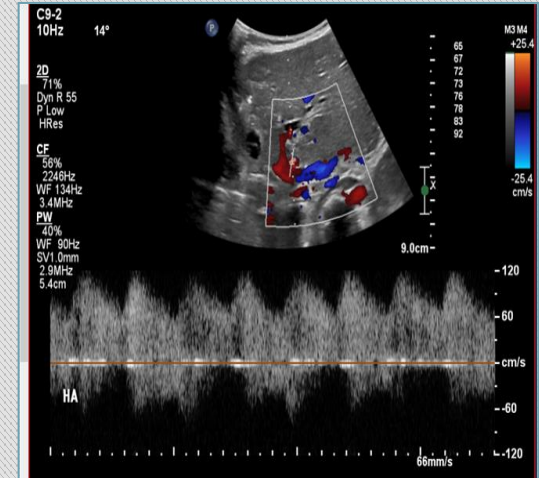
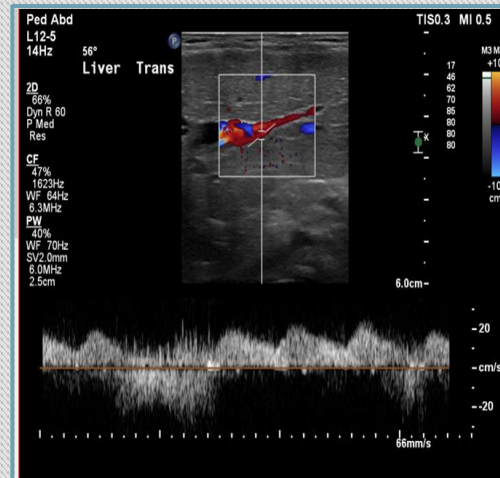
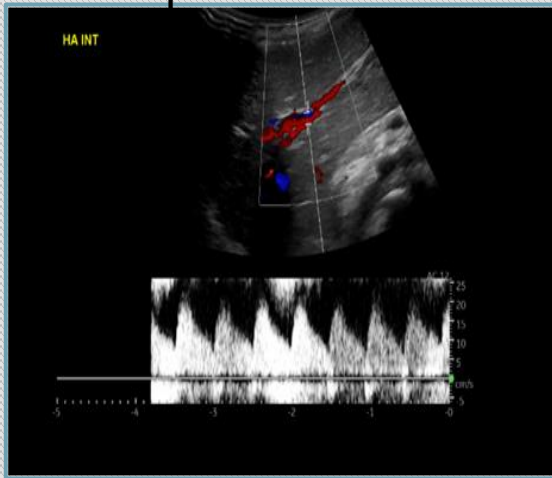




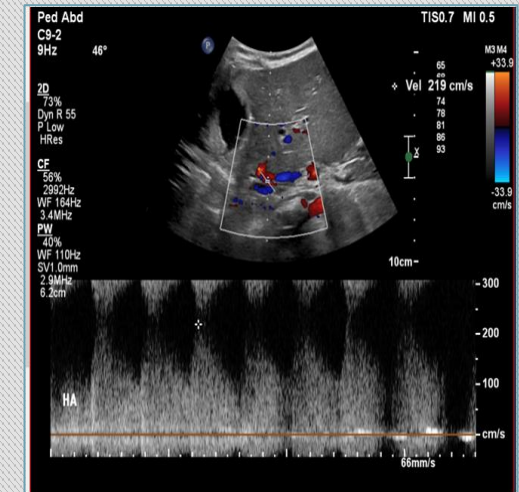
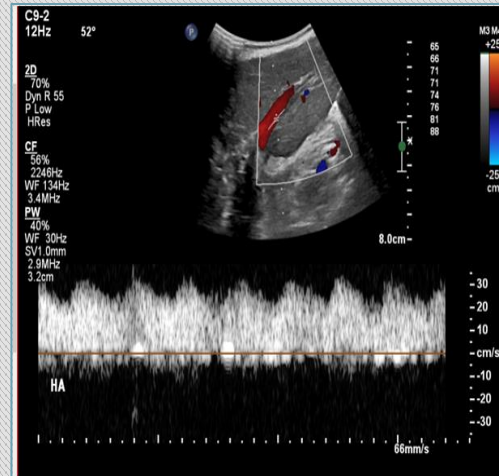
# HA stenosis

1 year old : day 7

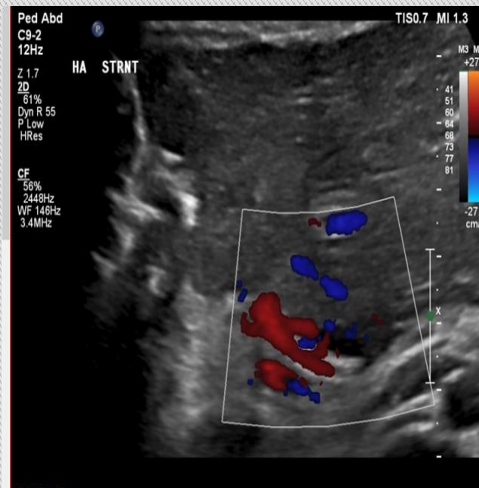
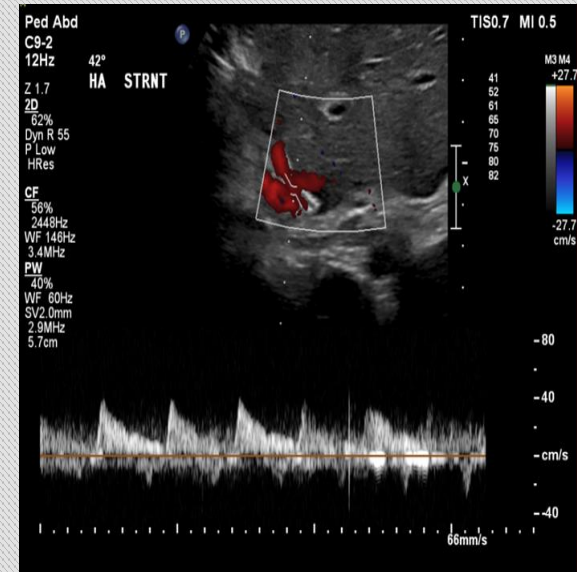
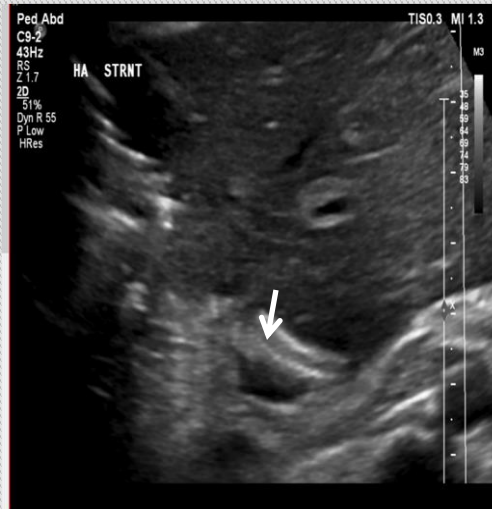
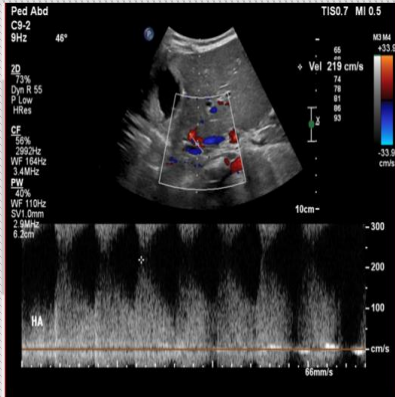
3months



- Review previous imaging for change in spectral trace.
- Assess the HA both in and out of liver
- Identify a high velocity jet >200cm/sec



# HA angiography & stent

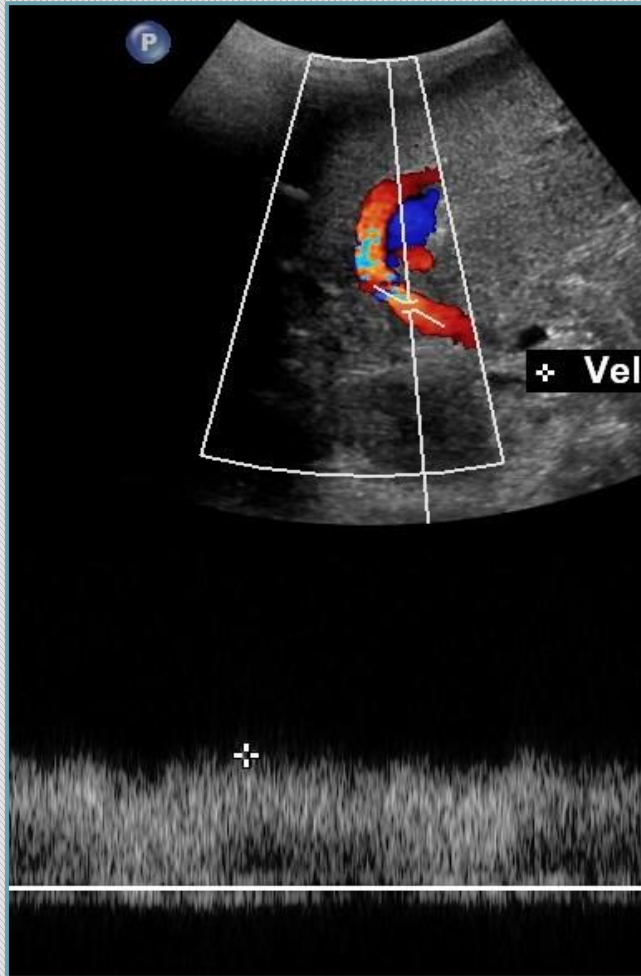


US follow up – patent stent

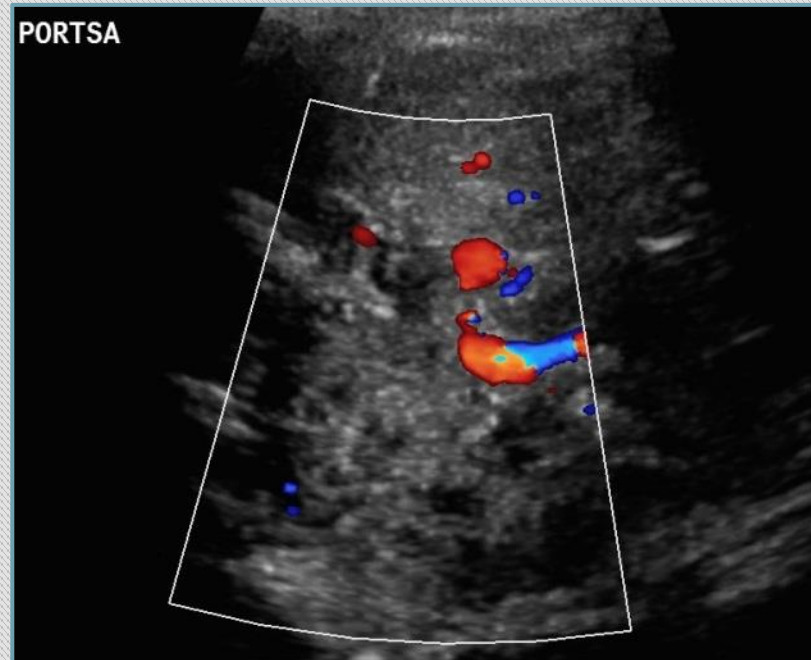


# Portal vein assessment

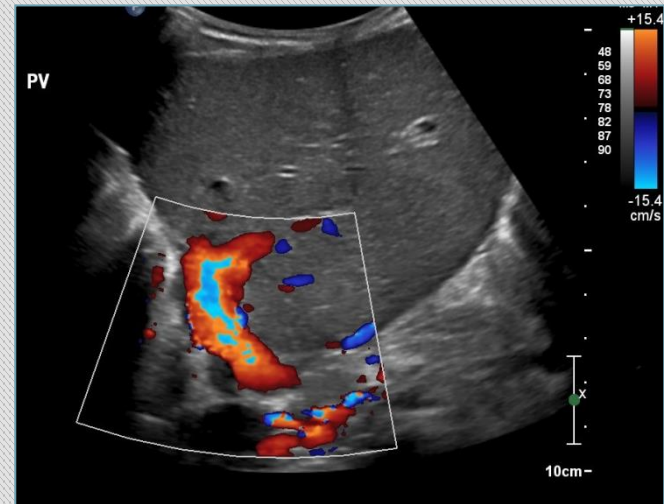
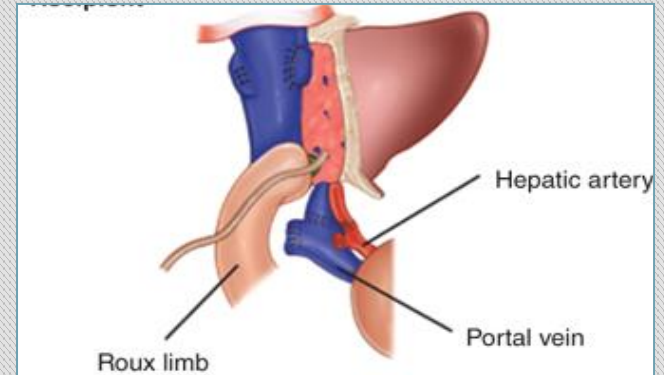
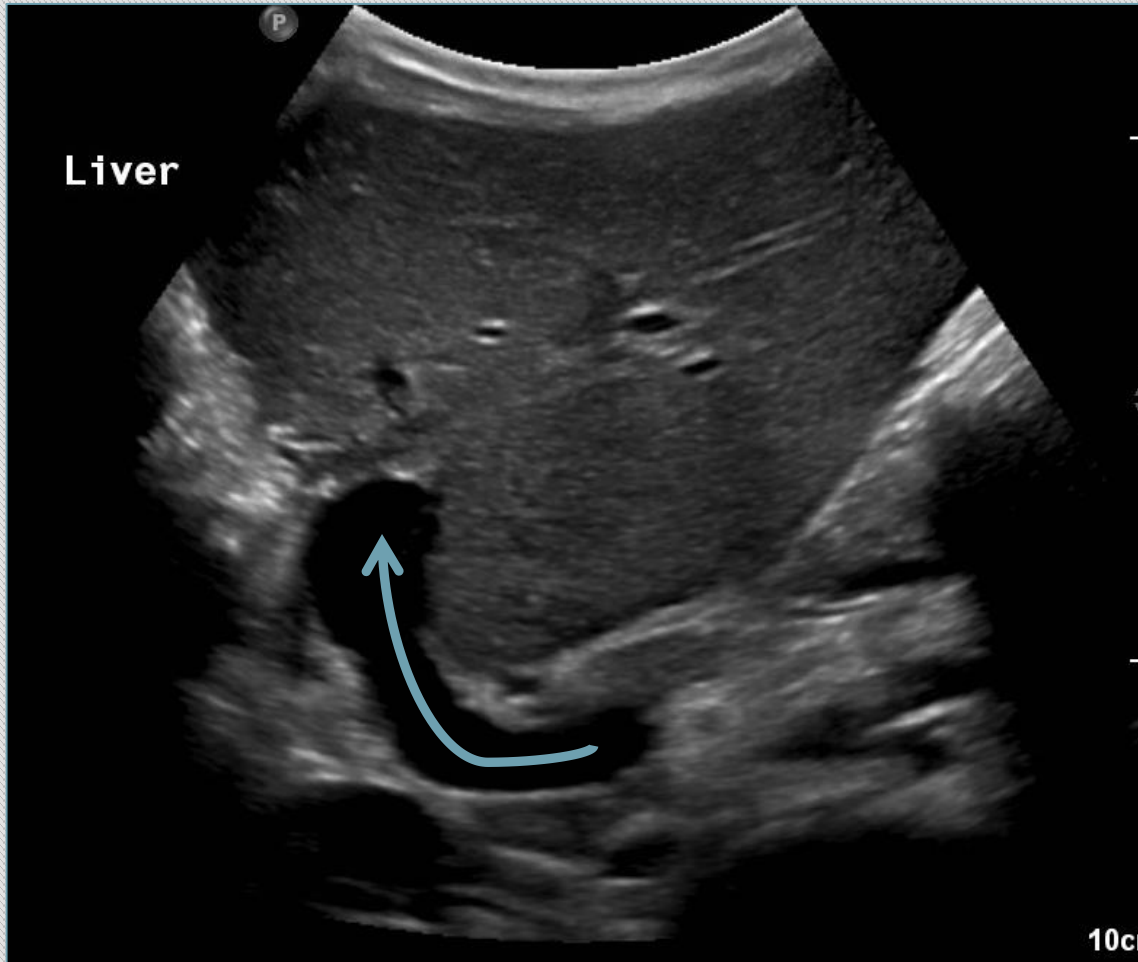
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Is it patent?  
PV thrombus not common



# Portal vein - split graft

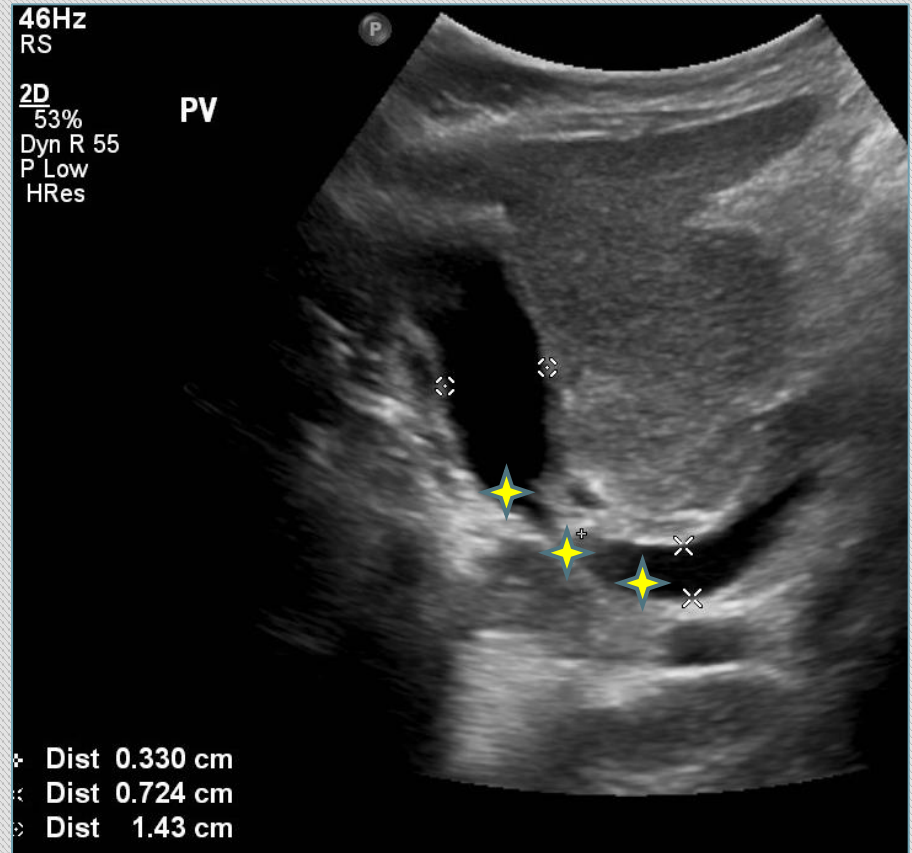




# Portal vein assessment

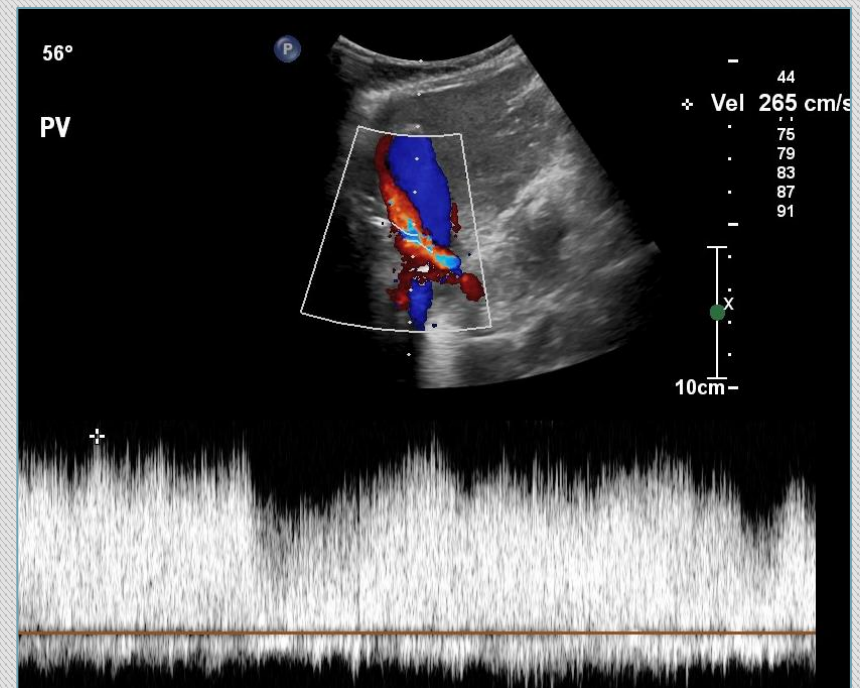
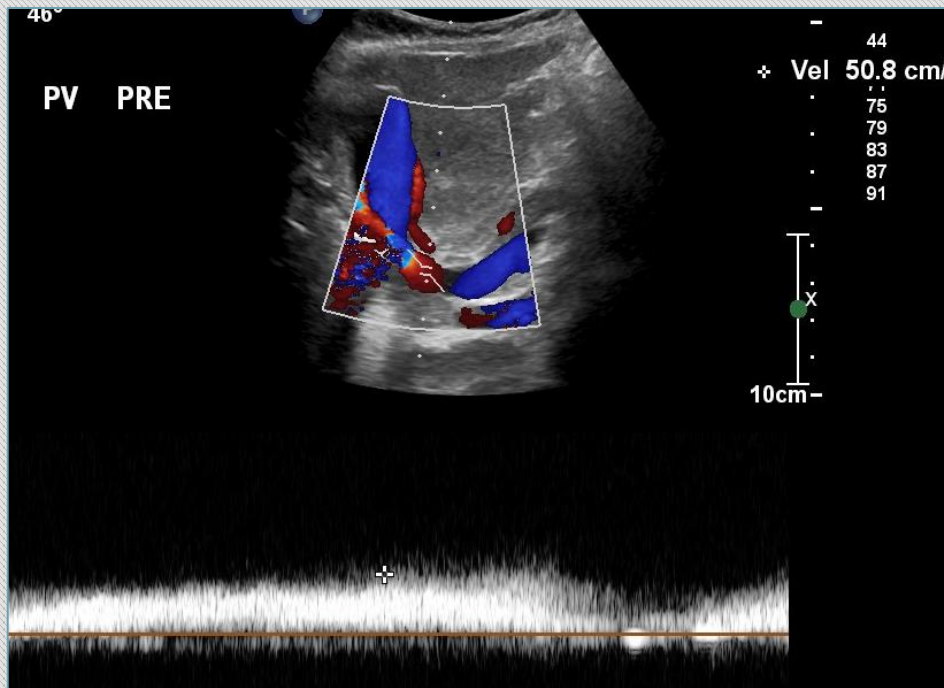
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- ▶ Stenosis usually at site of anastomosis
- ▶ Can have vessel calibre difference
- ▶ Measure velocity at anastomosis , pre & post anastomosis



# Portal vein stenosis

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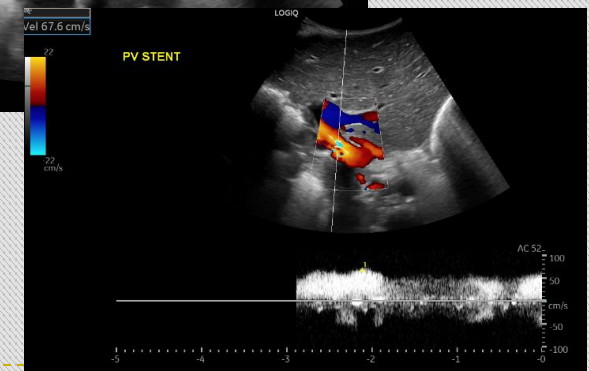
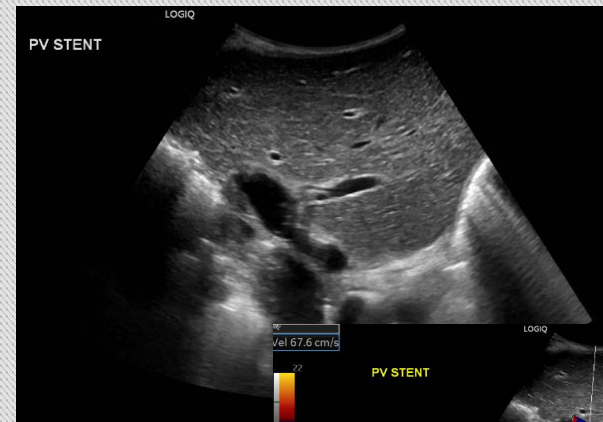
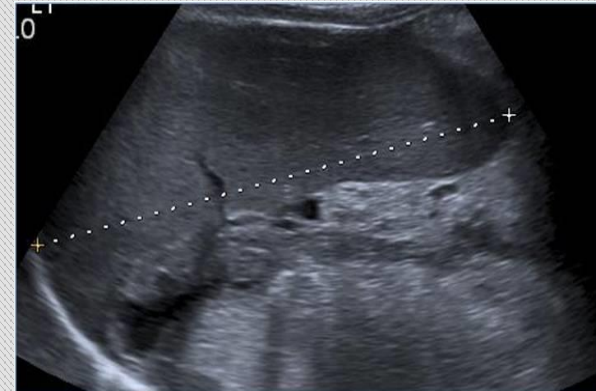
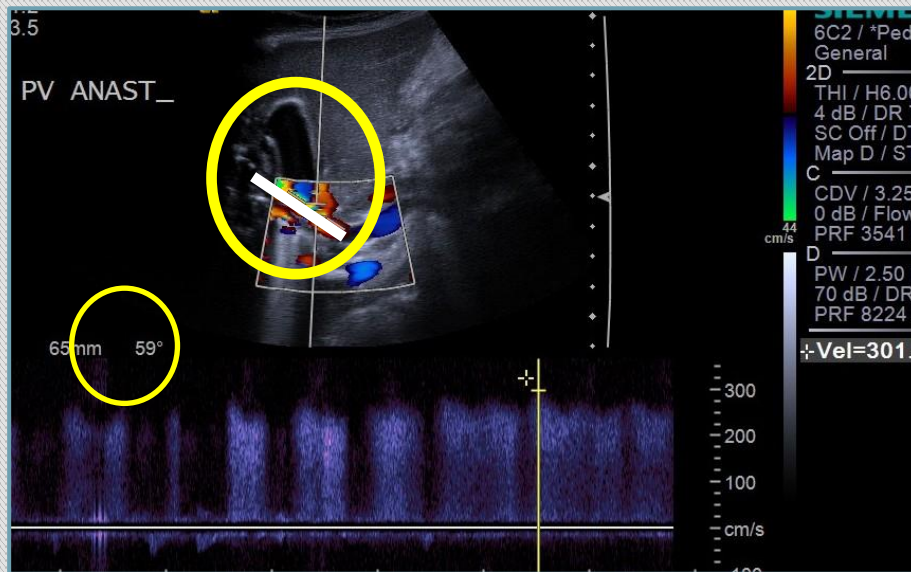


Velocity at stenosis 3-4 x that in the pre-stenotic vessel  
(often see turbulence and high velocity in first week post op - stenosis unlikely before 4 weeks)

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# Portal vein stenosis



- Accurate velocity measurement is important

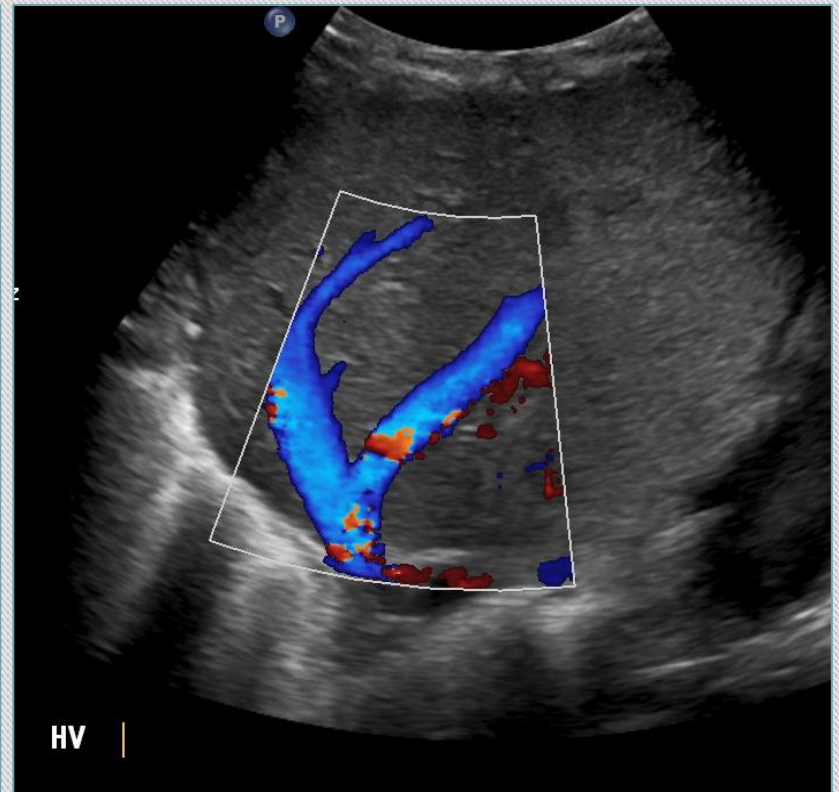
- PV stenosis leads to Increase in spleen size

- If spleen increasing re-check PV



# Hepatic vein/IVC assessment

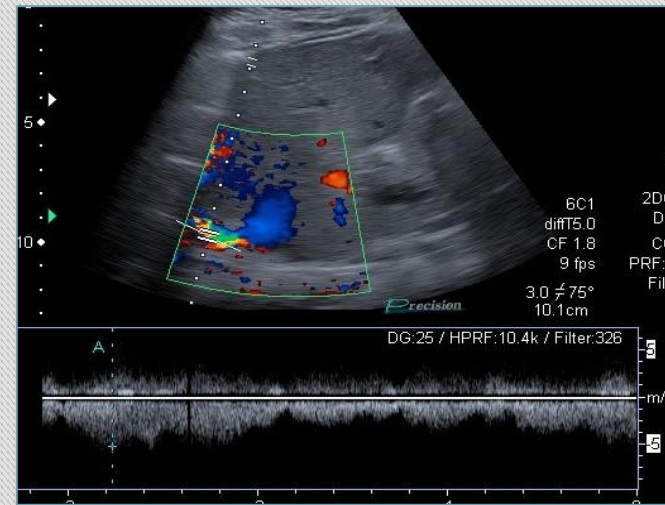
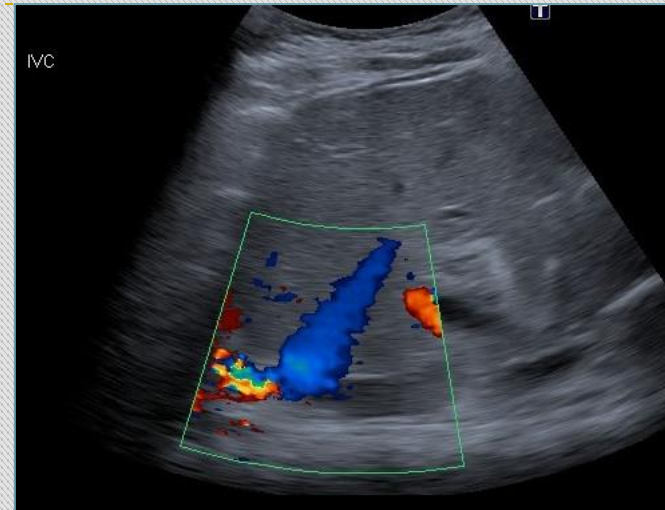
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# HV/IVC anastomosis

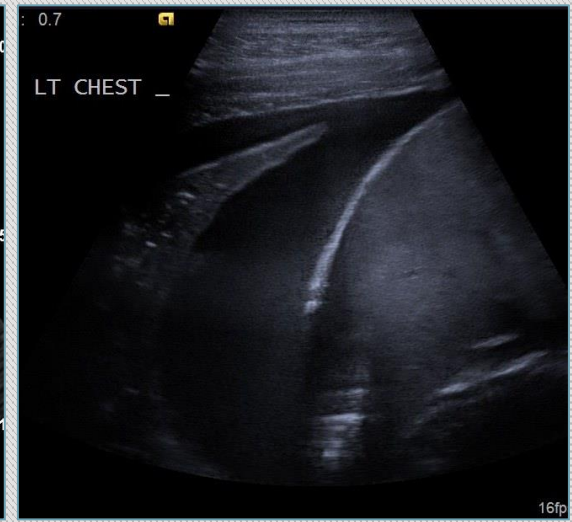
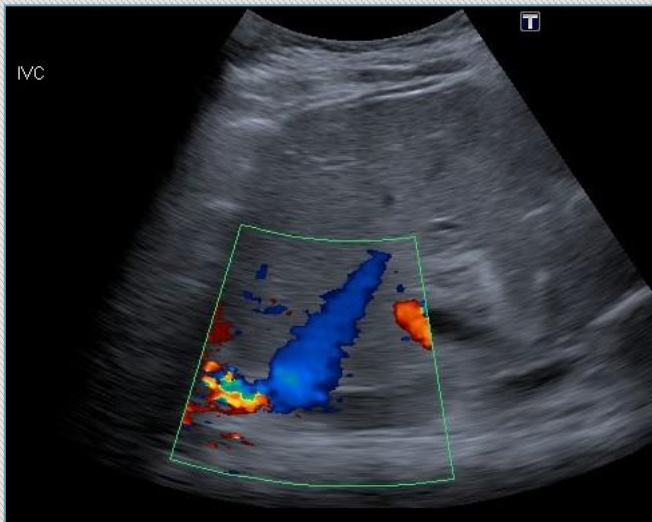
- ▶ Assess patency
- ▶ Measuring velocity is more ad- hoc
- ▶ May see pinching at anastomosis
- ▶ Aliasing of colour doppler



# HV/IVC anastomosis

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- ▶ Ultrasound is unreliable at predicting strictures
- ▶ Only proceed to venography if there is a high level of clinical suspicion (persistent ascites & pleural effusion).



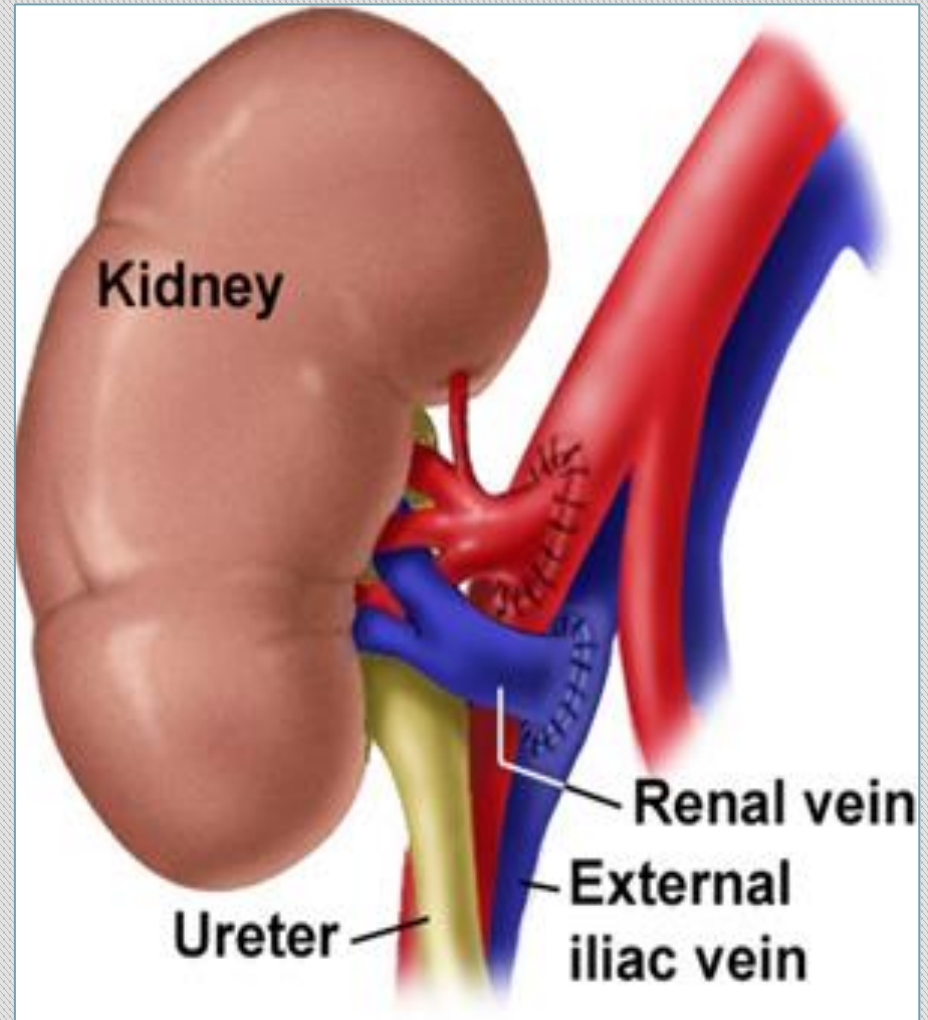
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# **Renal TX anatomy & anastomoses**



# Renal Tx anatomy and anastomoses

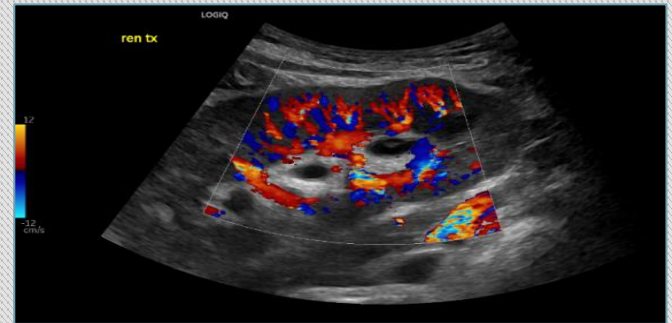
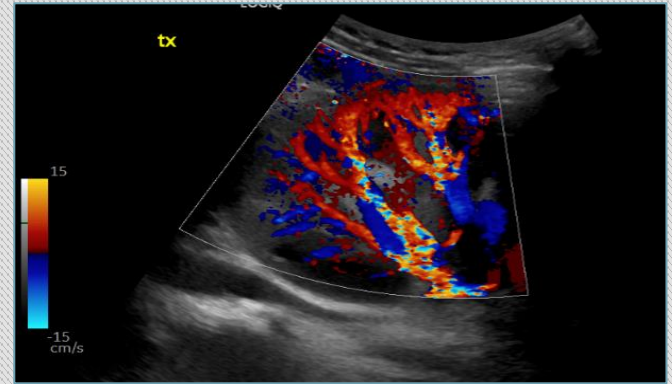
- ▶ Usually in RIF
- ▶ Operative information is helpful. May have more than one artery.
- ▶ Anastomoses are potential sites of stricture



# Vascular assessment of Renal TX

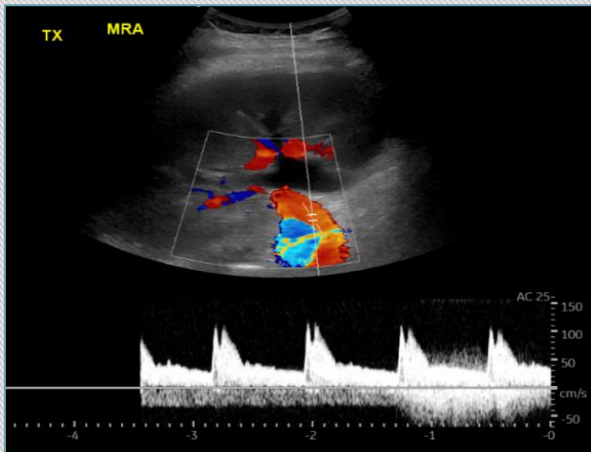
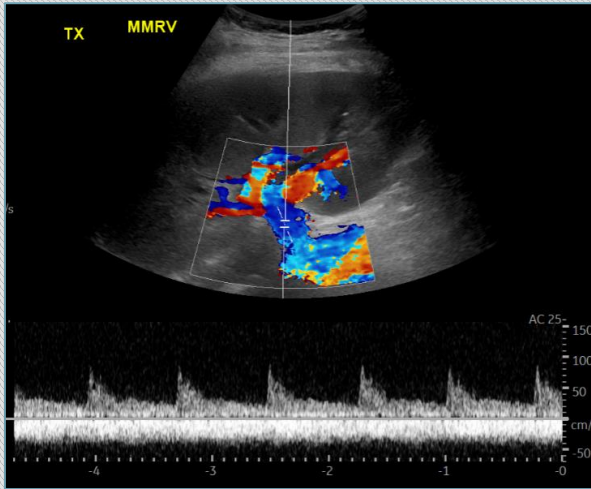
## ▶ Perfusion:

- ▶ Assess entire kidney using CFD
- ▶ Ensure no focal areas lacking perfusion
- ▶ Ensure low PRF and adequate CFD gain (just below noise)
- ▶ Use power Doppler or micro flow if necessary

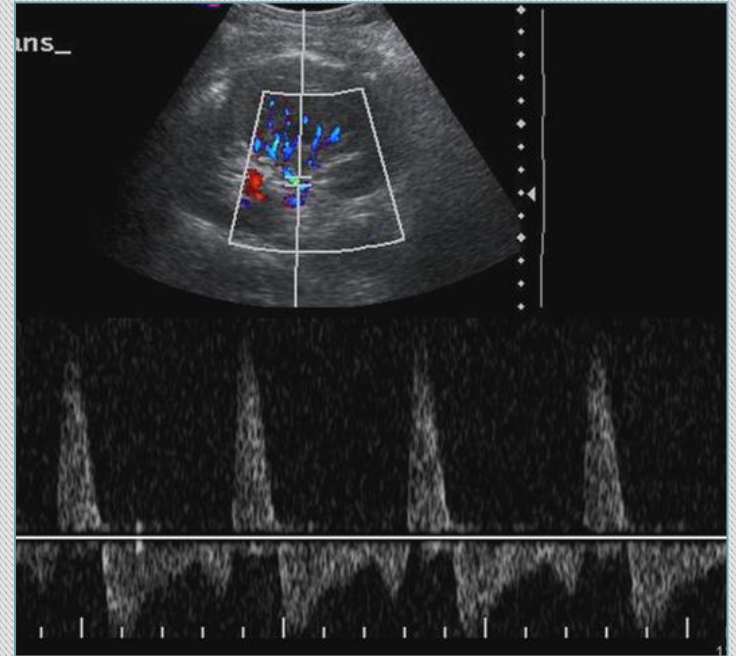


# Vascular assessment of renal Tx

- ▶ Ensure MRV & MRA patent



- ▶ Renal vein thrombosis



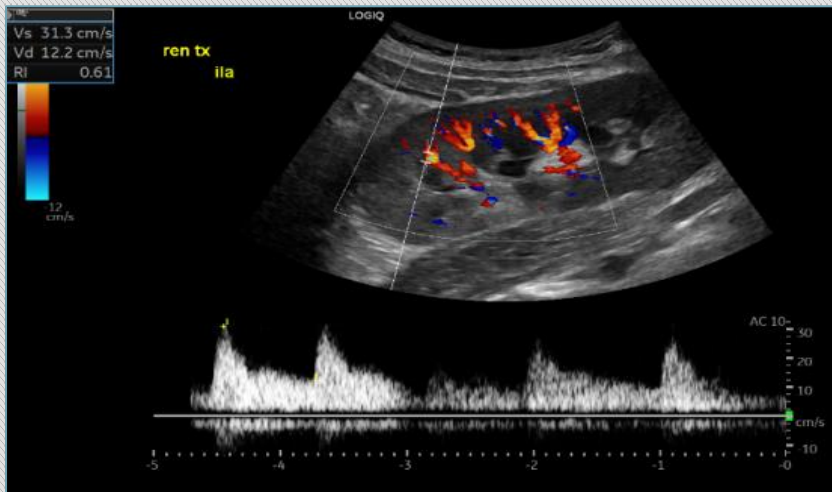
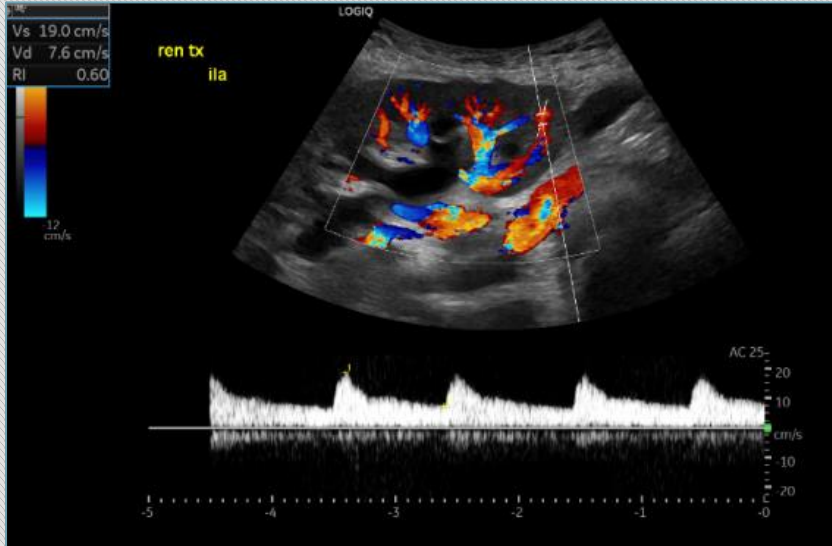
Reversed end diastolic flow in MRA  
Reduced general perfusion





# Resistive index: measure upper, mid and lower pole

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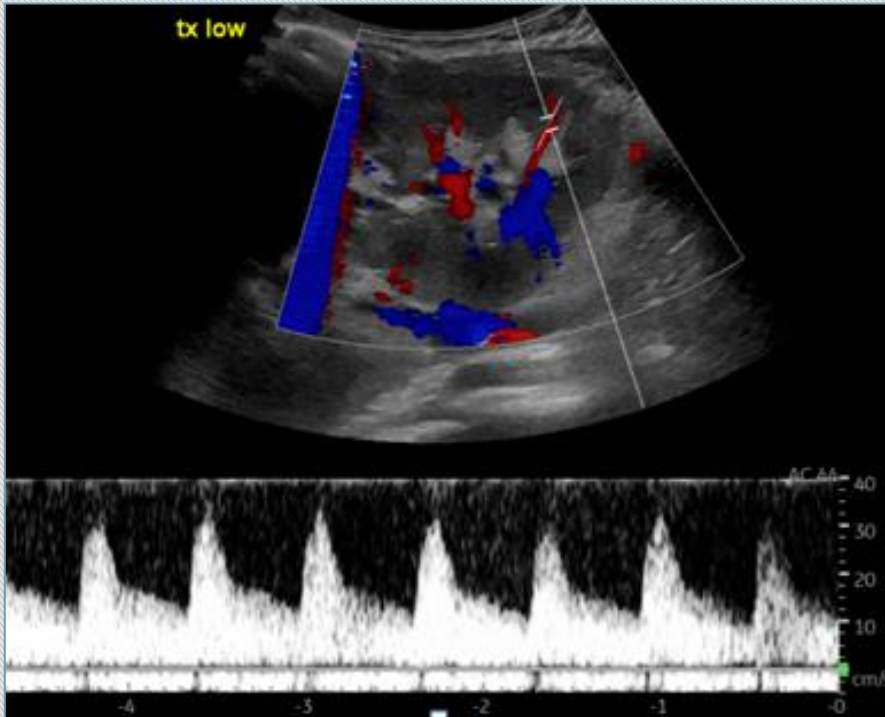
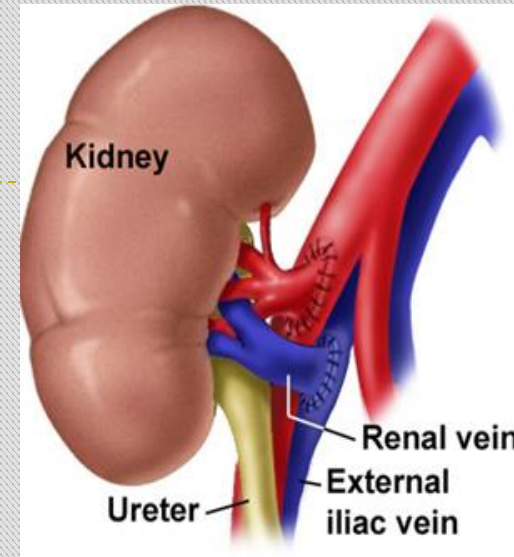


Elevated RI (>75-80)

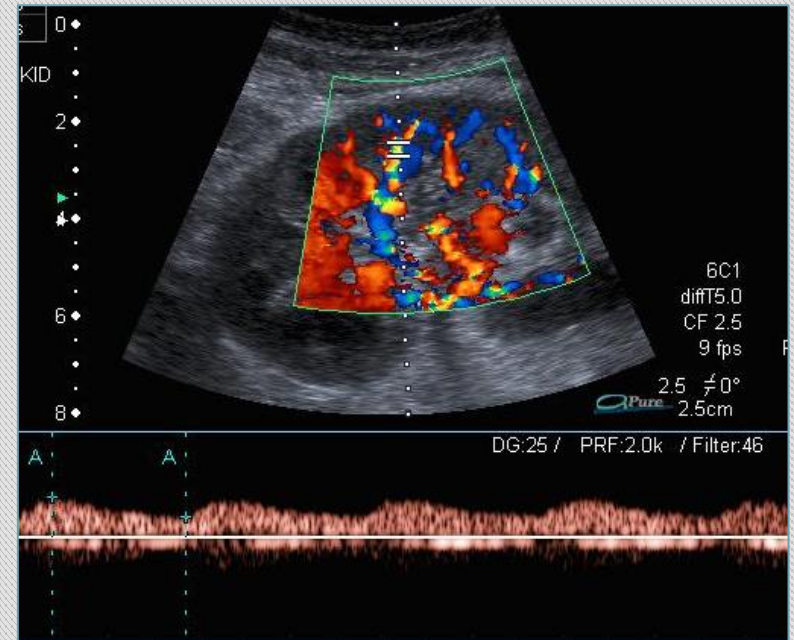
- ▶ Acute rejection
- ▶ Acute tubular necrosis
- ▶ Hydronephrosis
- ▶ Infection
- ▶ External pressure
- ▶ Renal vein thrombosis



# Assess waveform



Normal



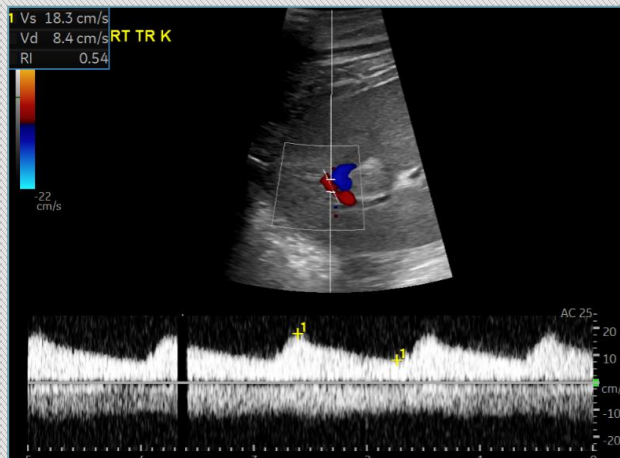
Parvus Tardus



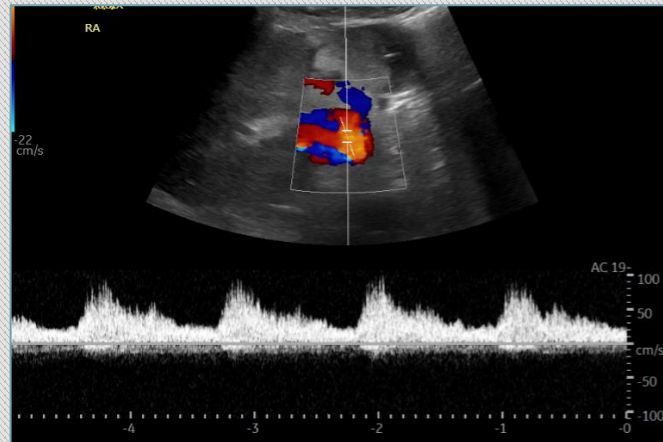
# Renal artery stenosis

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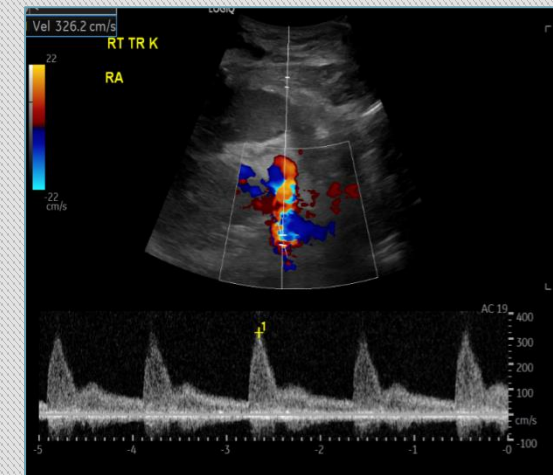
6 year old boy, raised creatinine 2 weeks post transplant



Parvus tardus ILA



Reduced upstroke MRA

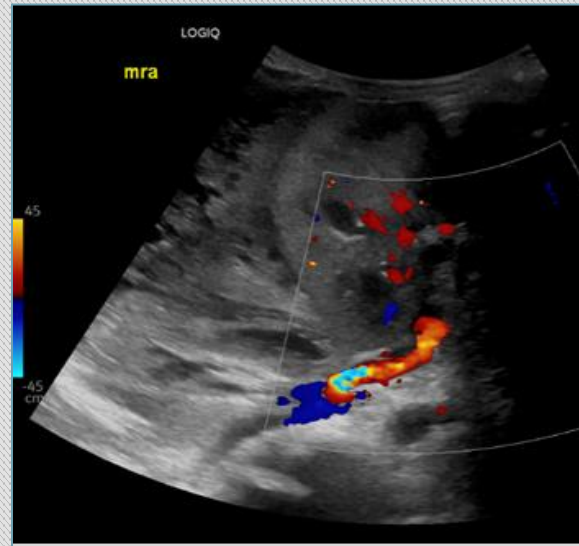
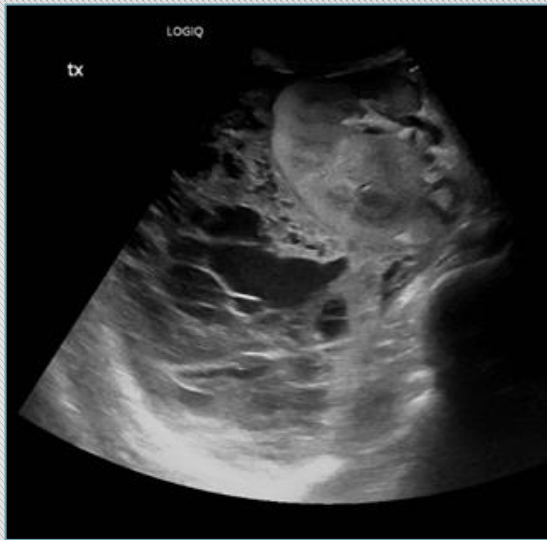


326cm/sec anastomosis

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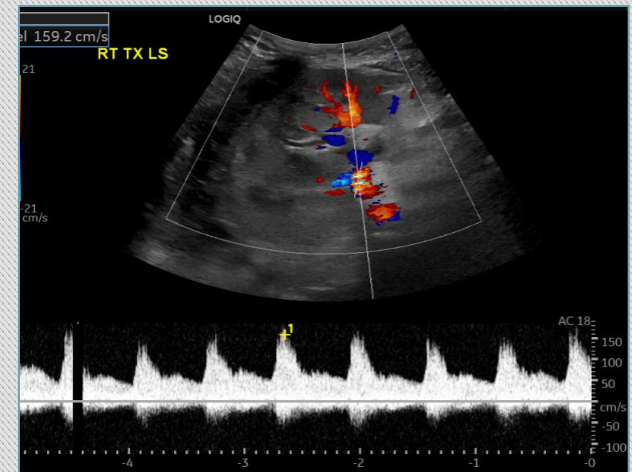


# Renal artery stenosis



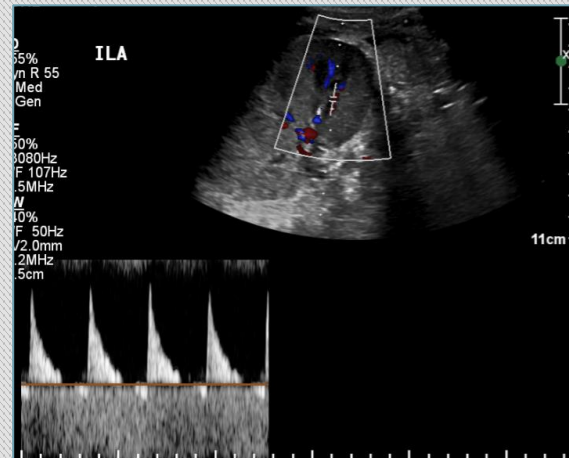
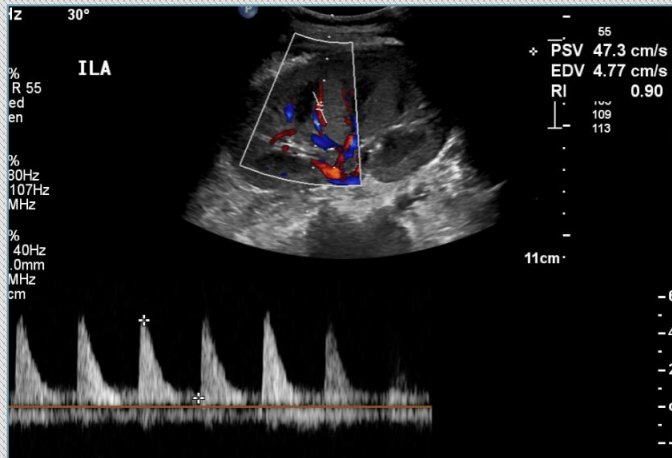
12 year old boy large post operative seroma

Resolved post drain

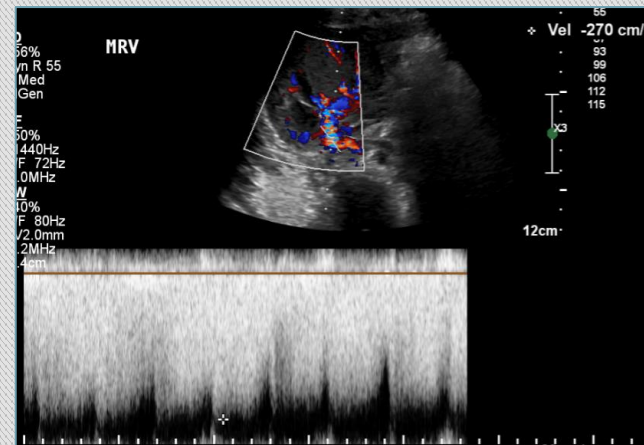
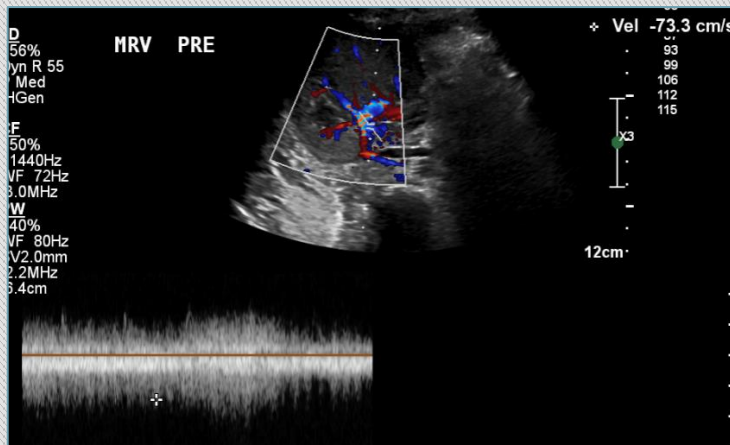


# Renal vein stenosis

- ▶ 4 year old boy rising creatinine and hypertensive



Renal vein stricture causing swollen kidney and reversal of end diastolic flow



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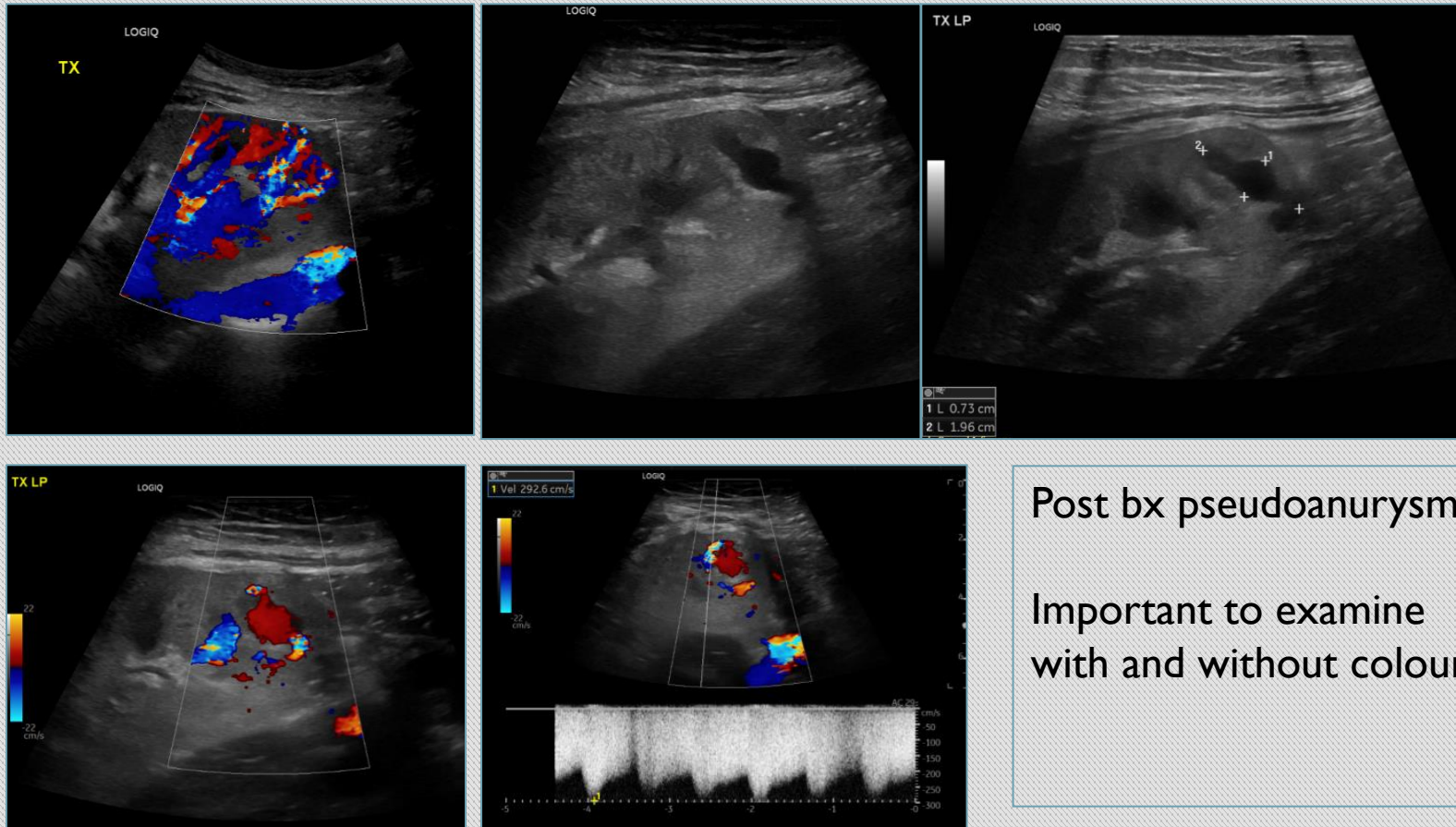
# Post biopsy vascular complications

Liver and renal transplants undergo biopsy to assess for rejection



# Post biopsy vascular complications

- ▶ 13 year old girl pain post biopsy



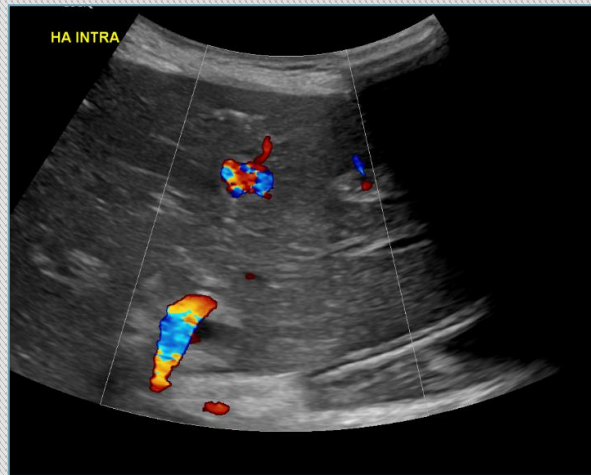
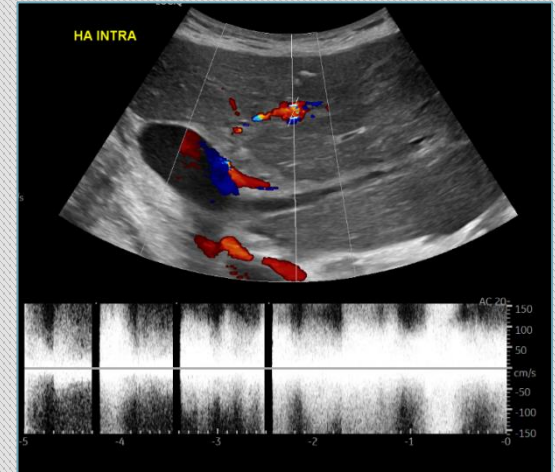
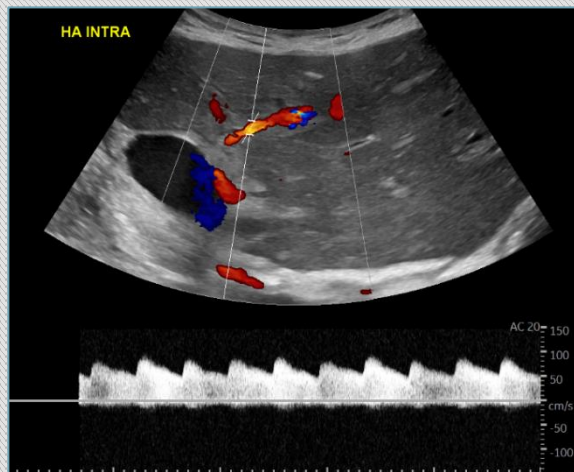
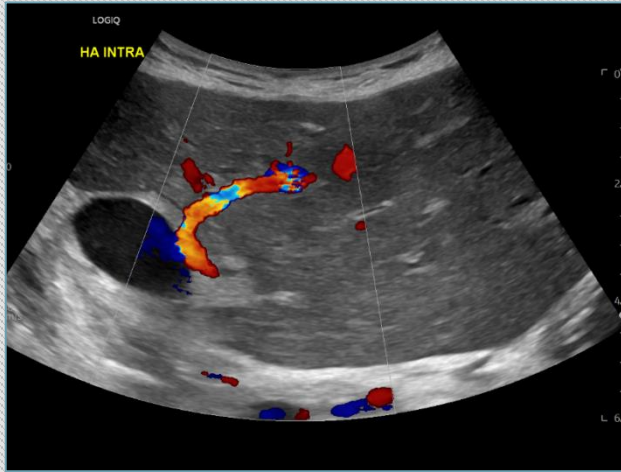


# Pseudoaneurysm confirmed with angiography & occluded with coil

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# Post biopsy AV fistula in liver tx



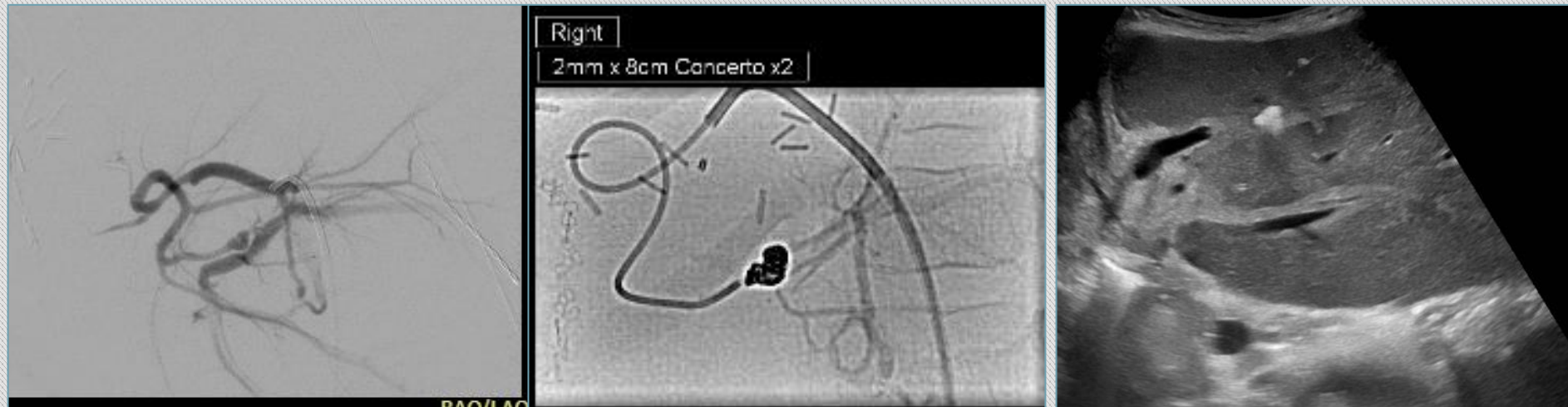
Note aliasing and  
turbulent flow

Examine with and without  
colour doppler



# AV fistula and communicating PA confirmed with angiography & occluded with coil

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# Vascular assessment of Liver & Renal Tx learning points

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- ▶ Operative information is extremely helpful –anastomoses are potential problems
- ▶ Good doppler technique is key in post transplant assessment
- ▶ Use appropriate angle correction to obtain accurate vessel velocities -  $<60^\circ$
- ▶ Always sample vessels both in and out of the transplanted organ
- ▶ Always examine with and without colour doppler



# ***Thank you***

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