Go with the Flow: A Guide to Understanding Kidney Transplants

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Objectives

- Discuss indications for needing a renal transplant and barriers to receiving one
- Review the anatomy involved during surgery and alternate approaches in complex cases
- Review case studies depicting pathology demonstrated in postoperative ultrasounds and recognize when reintervention is required

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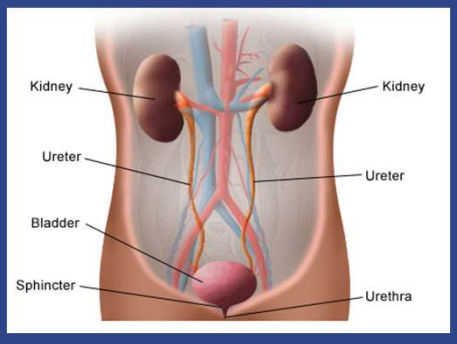
Kidneys

- Most of us are born with two!
- Main purpose is to filter and remove waste from the blood by producing urine
  - When the kidneys stop doing this, it leads to end-stage renal disease
    - Loss of 90% of function[1]
  - Dialysis or renal transplant is needed to stay alive



Anatomy of the Urinary System. https://www.healthcarefirst.org/useful/wellness-and-prevention/anatomy-of-the-urinary-system/ Accessed Jun. 30, 2025

4

End-Stage Renal Disease

- What causes this? – Many potential things[2]
  - Diabetes
  - Chronic and uncontrolled hypertension
  - Pyelonephritis
  - Obstructive uropathy
  - Gomerulonephritis
  - Polycystic kidney disease
  - Congenital urinary tract abnormalities
  - IgA nephropathy
  - Various syndromes

Schoenherr N. NIH grant will fund study on how communities address diabetes. 2019. Accessed Jun. 30, 2025

What's The Connection Between Hypertension and Cardiovascular Disease Accessed Jun. 30, 2025

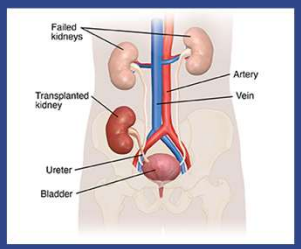
PKD Awareness Day. Accessed Jun. 30, 2025

5

Lifetime Dialysis vs Kidney Transplant

Home H. Dialysis Treatment: How It Can Improve Kidney Function. 2020. Accessed Jun. 30, 2025

Free illustrations and vector art: VS character. Accessed Jun. 30, 2025



Kidney Transplantation. Accessed Jun. 30, 2025

- Kidney transplant is normally preferred and recommended if able[1]
  - Lower risk of death
  - Higher quality of life
  - Lower cost of treatment
  - Less dietary restrictions

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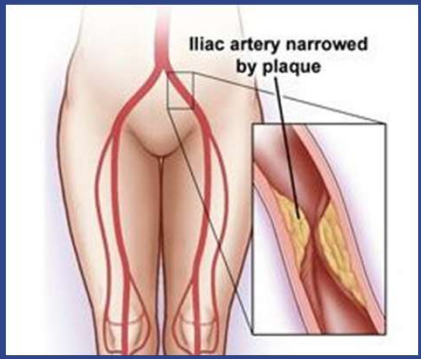
Contraindications for Kidney Transplant[1,2]

- Advanced age
- Malignancy within last two years
- Non-compliance with medication
- Severe coronary artery disease
- Aorto-iliac vascular disease
- Lack of social support
- Severe malnutrition
- Dementia or Severe Mental Illness
- Alcohol or Drug Abuse



Aortoiliac Occlusive Disease. [illegible] Accessed Jun. 30, 2025

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Deceased Donors[3]

- Broken into two categories:
  - Deceased due to brain death
  - Deceased due to cardiac death
- Potential donor kidney is evaluated for suitability based on kidney donor profile index (KDPI)
- Factors in KDPI:
  - Donor age, creatinine, ethnicity, diabetes, hypertension history, cause of death, weight, height, and hepatitis C status.
- Accepting a “less optimal” tx is still associated with improvement in life expectancy and reduced morbidity
  - Also financially beneficial compared to maintenance dialysis for years

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Living Donors[3]

- Best chances of recipient and graft survival
  - Even when considering a paired kidney exchange that includes organ transportation
- Requirements to be eligible as a donor:
  - Age 18-70, BMI less than 35kg/m, GFR > 80 –adequate kidney function, no active infections or malignancy
- Contraindications:
  - Diabetes, BMI greater than 40kg/m, GFR < 70mL/min/1.72m, active malignancy, HIV, albuminuria, hypertension requiring more than one medication, pelvic kidneys, horseshoe kidney, and psychiatric disorders
- Consequences:
  - ESRD development in living donors was marginally higher compared to healthy controls, but no different compared to the general population

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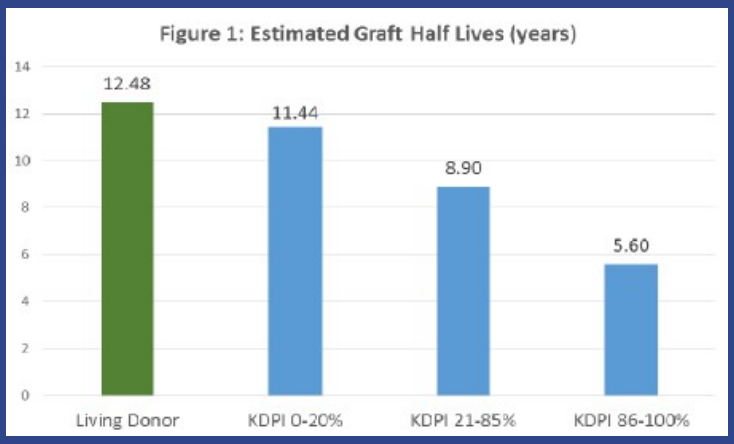
Deceased and Living Donors



Kidney Donor Profile Index (KDPI) Guide for Clinicians [Internet]. U.S. Department of Health & Human Services, Organ Procurement & Transplantation Network; [cited 2025 Jun 30]. Available from: https://optn.transplant.hrsa.gov/professionals/by-topic/guidance/kidney-donor-profile-index-kdpi-guide-for-clinicians/

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Technique[3,5]

- Laparoscopic or robotic surgery most commonly used for kidney procurement from donor
  - Open surgery less common in living donors
- Preservation:
  - Ischemia time begins when the normal perfusion stops and ends when organ is perfused in the recipient
  - Kidney should be kept cold as much as possible
    - Reduces injury and metabolic demand
  - Machine perfusion can also be used and is popular
    - Shown to reduce delayed graft function after transplant

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Technique

- Open surgery for tx recipient
  - Heterotopic placement of tx kidney in pelvis right or left side
  - Vessels anastomosed to external iliac artery and vein
  - Ureter anastomosed to bladder
  - Quadrant selection partially based on hx of renal tx or pancreas tx
- Multiple renal arteries[6]:
  - If deceased donor, may take patch from the aorta if arteries are close together
  - Pantaloons technique/side-to-side anastomosis
  - Direct anastomosis of separate arteries

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Technique

- Open surgery for tx recipient
- Robot Assisted[6]
  - Fewer complications
  - Reduced incidence of delayed graft function
  - Longer operative times
  - Greater physician learning curve
  - Newer so not as much long term data

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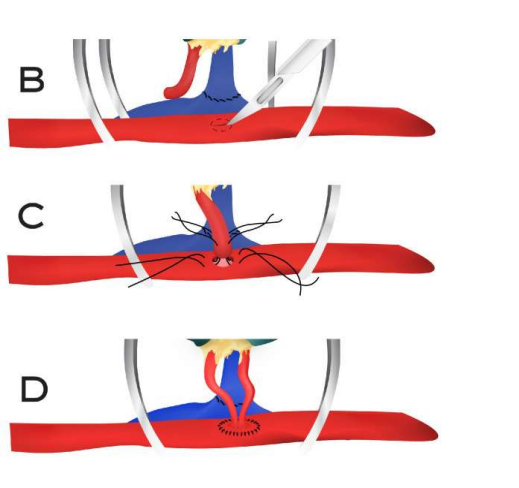
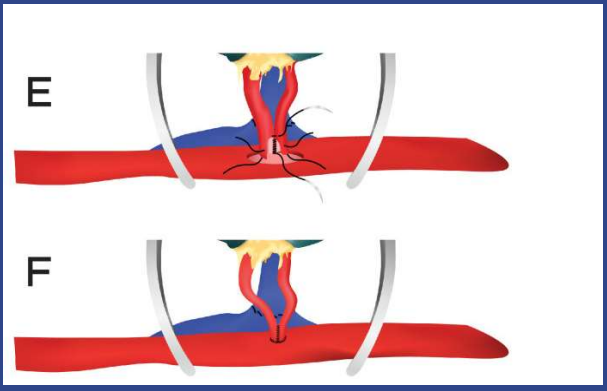
Technique





Novacescu D, Latcu SC, Raica M, Baderca F, Dumitru CS, Daminescu L, Bardan R, Dema V, Croitor A, Cut TG, Cumpanas AA. Surgical Strategies for Renal Transplantation: A Pictorial Essay. J Clin Med [Internet]. 2024 Jul 17 [cited 2025 Jun 30]; 13(14):4188. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC11278135/

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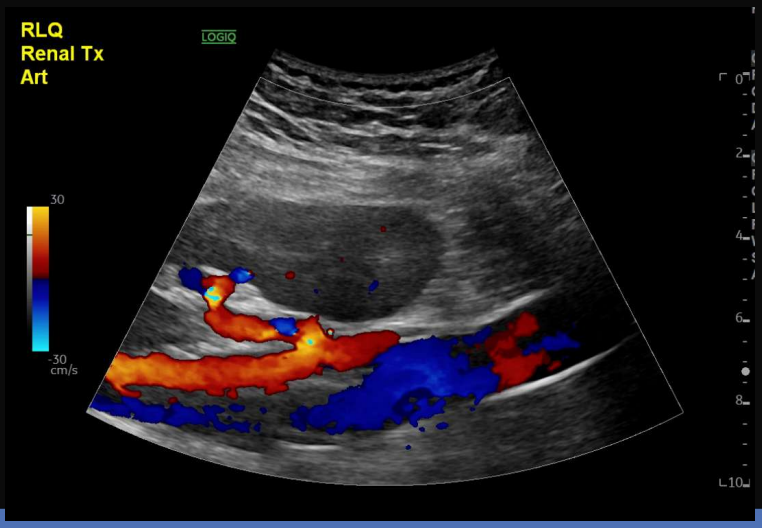
Single Renal Artery



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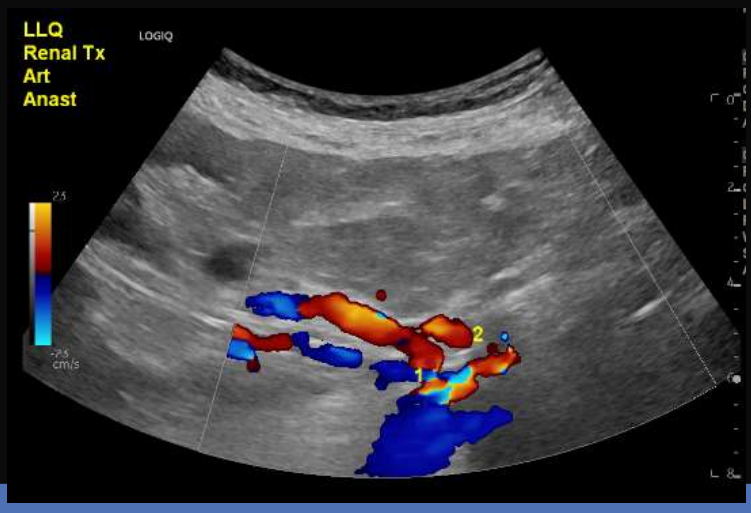
Multiple Renal Arteries



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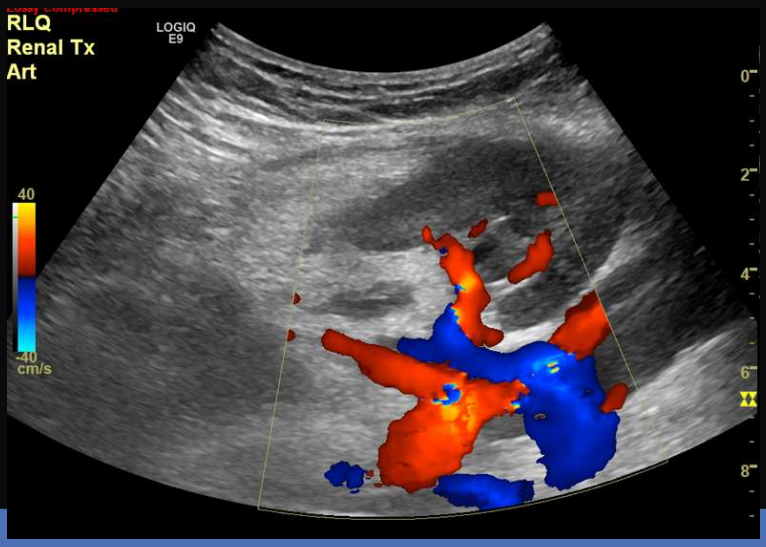
Multiple Renal Arteries



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Complications[3]

- Hemorrhage
- Renal vein thrombosis
- Arterial stenosis
- Infections
- Lymphocele
- Urinoma
- Graft failure/rejection
- Death, heart attack, or stroke

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Normal Renal Transplant

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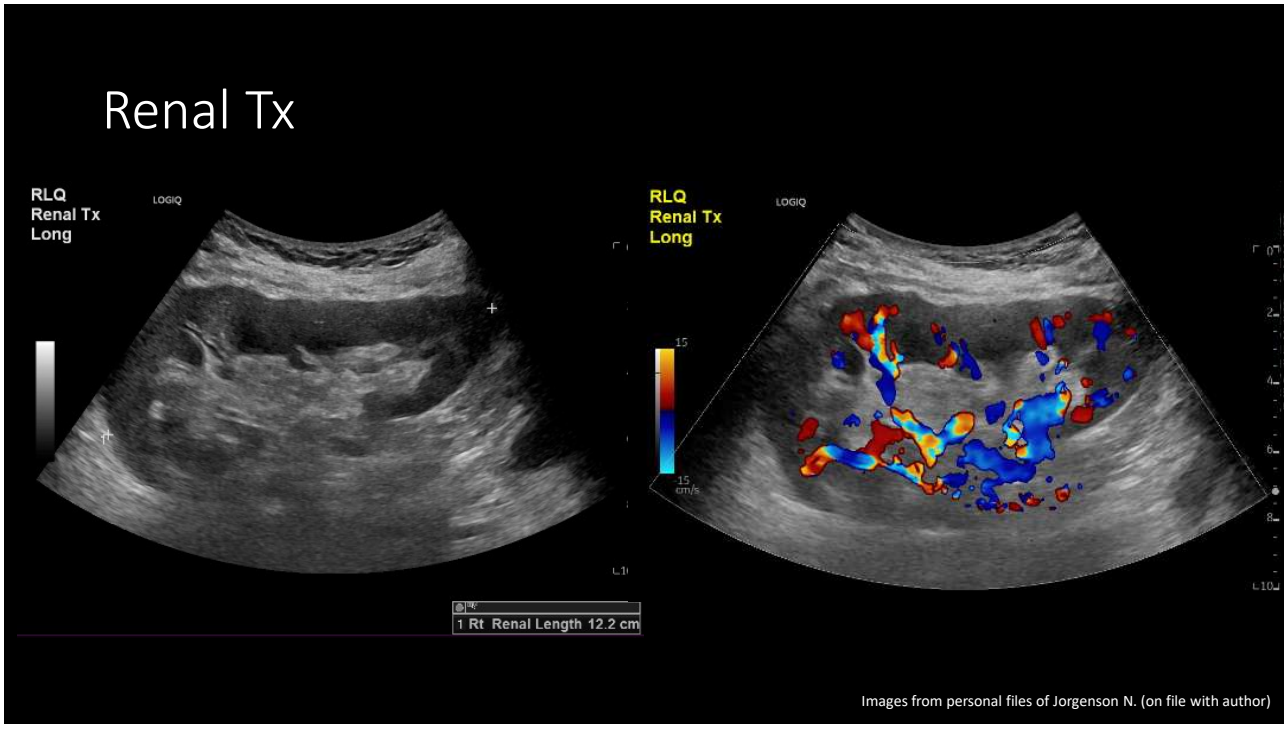
Renal Tx



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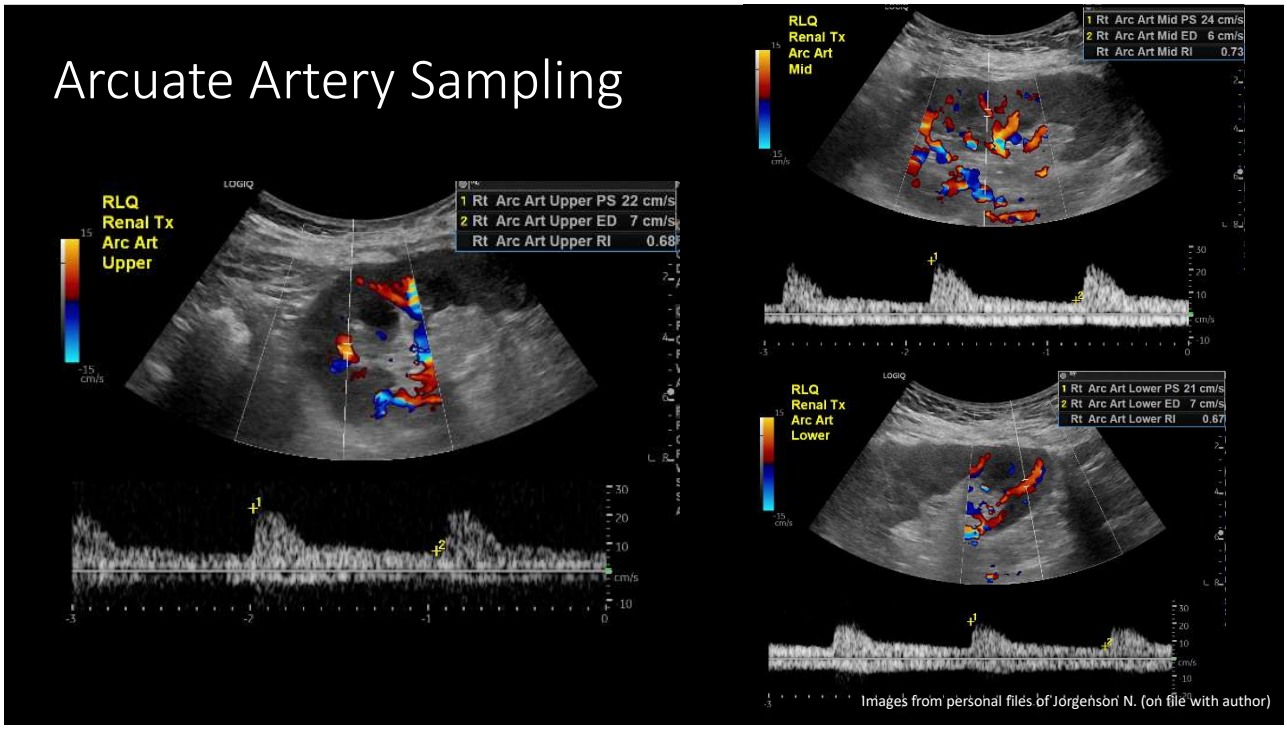
Arcuate Artery Sampling



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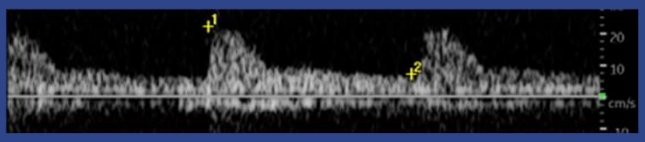
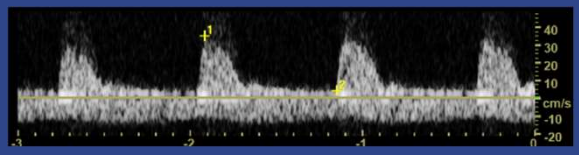
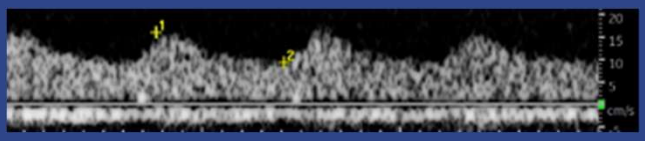
Resistive Index Criteria

- Normal: 0.50-0.75
- Borderline: 0.75-0.80
- Abnormal: Greater than 0.80, Less than 0.50







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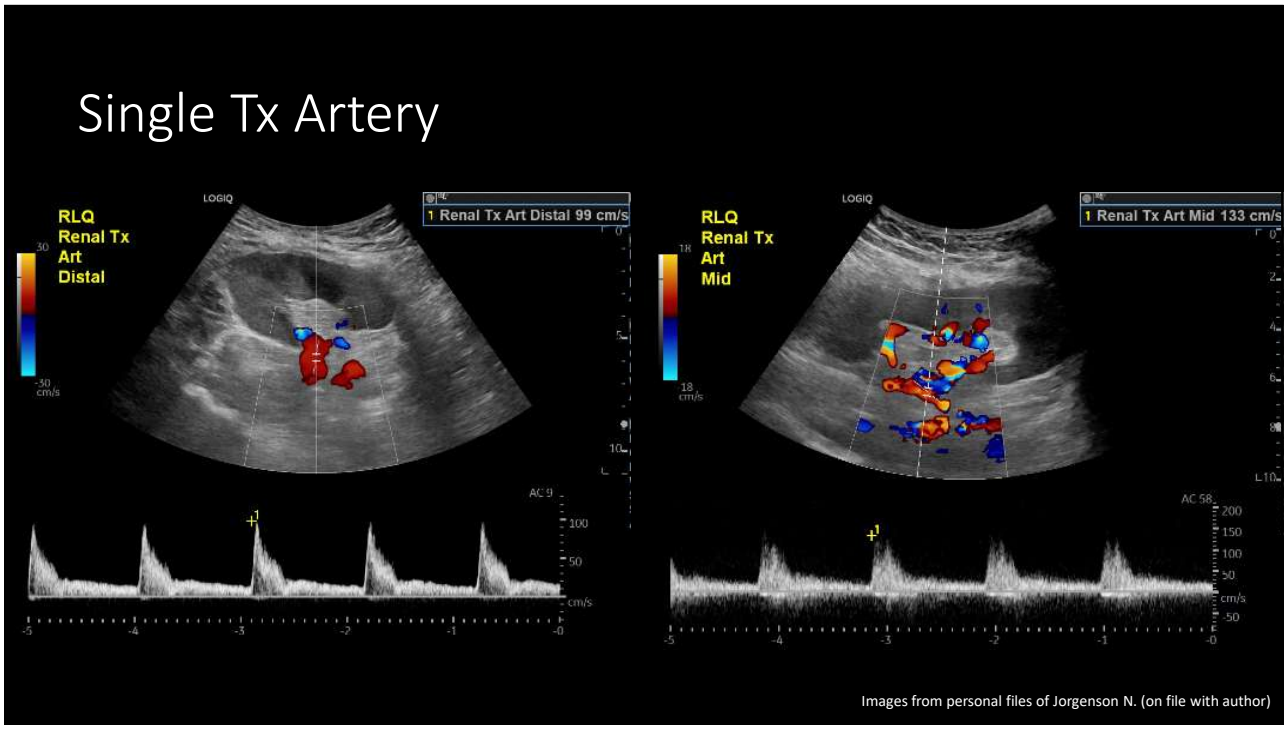

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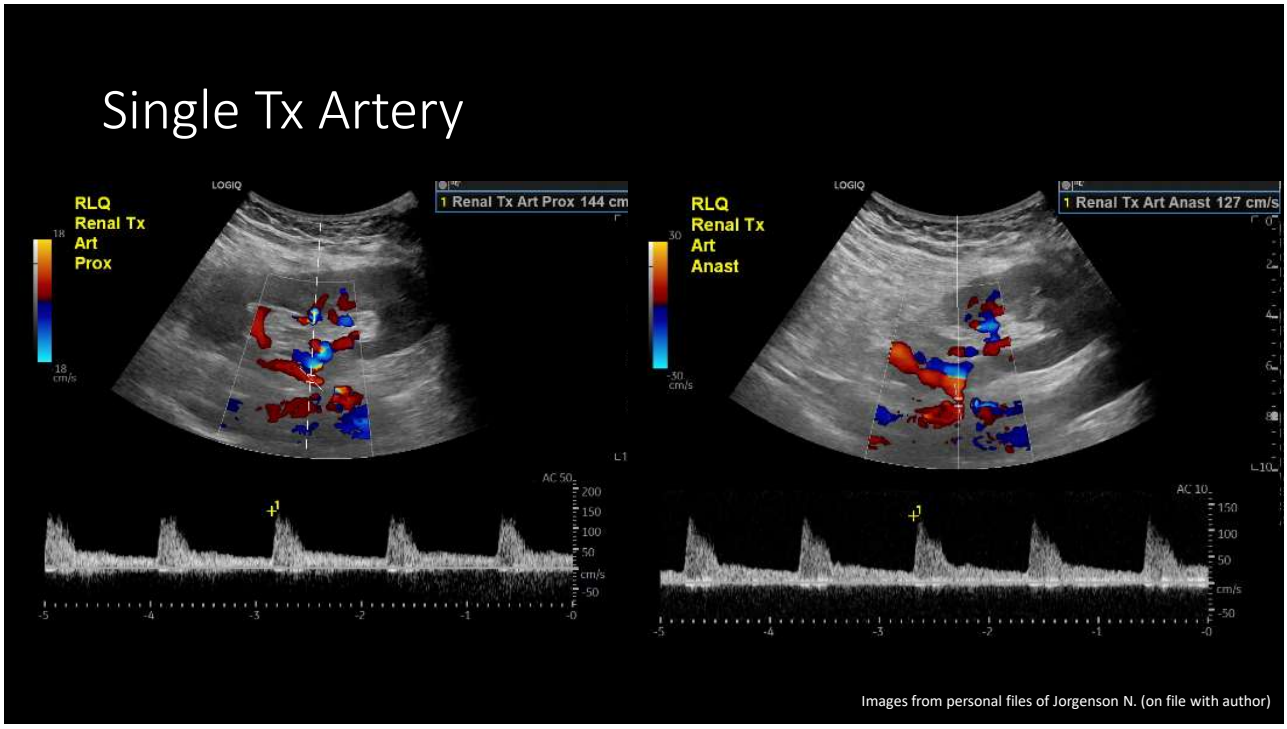

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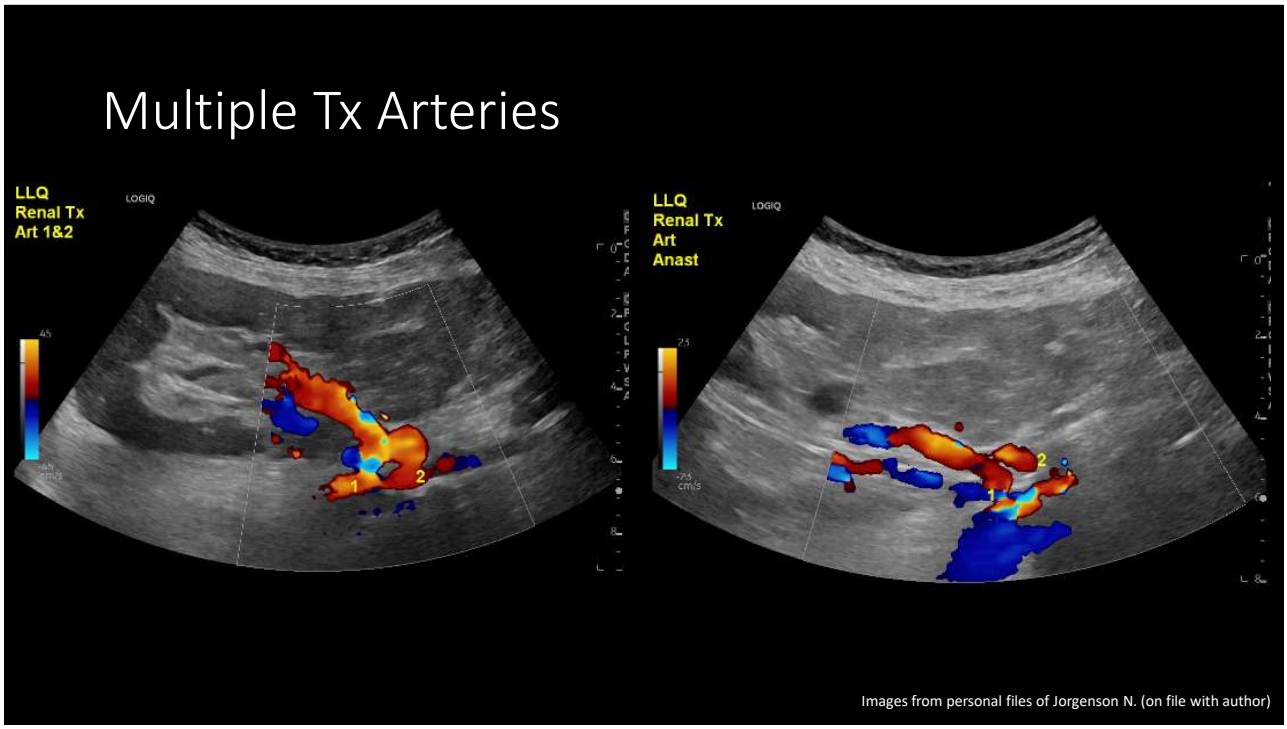
Multiple Tx Arteries



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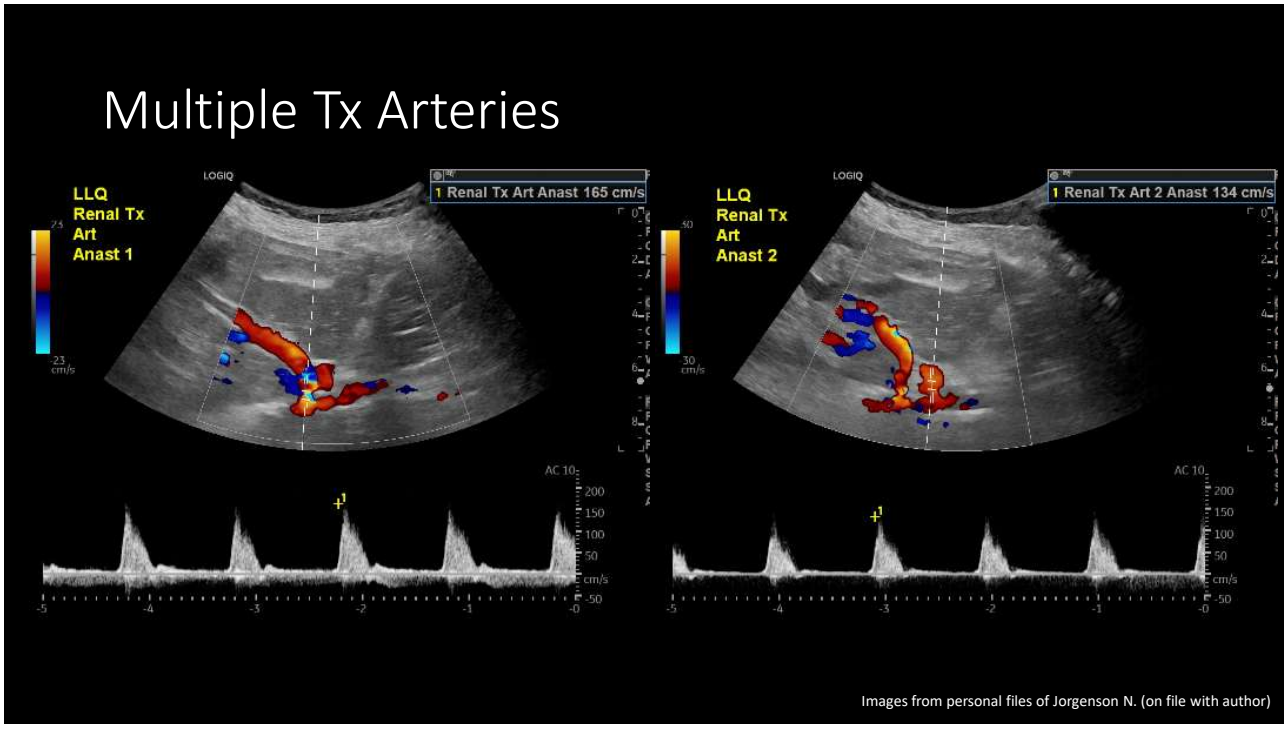
Multiple Tx Arteries



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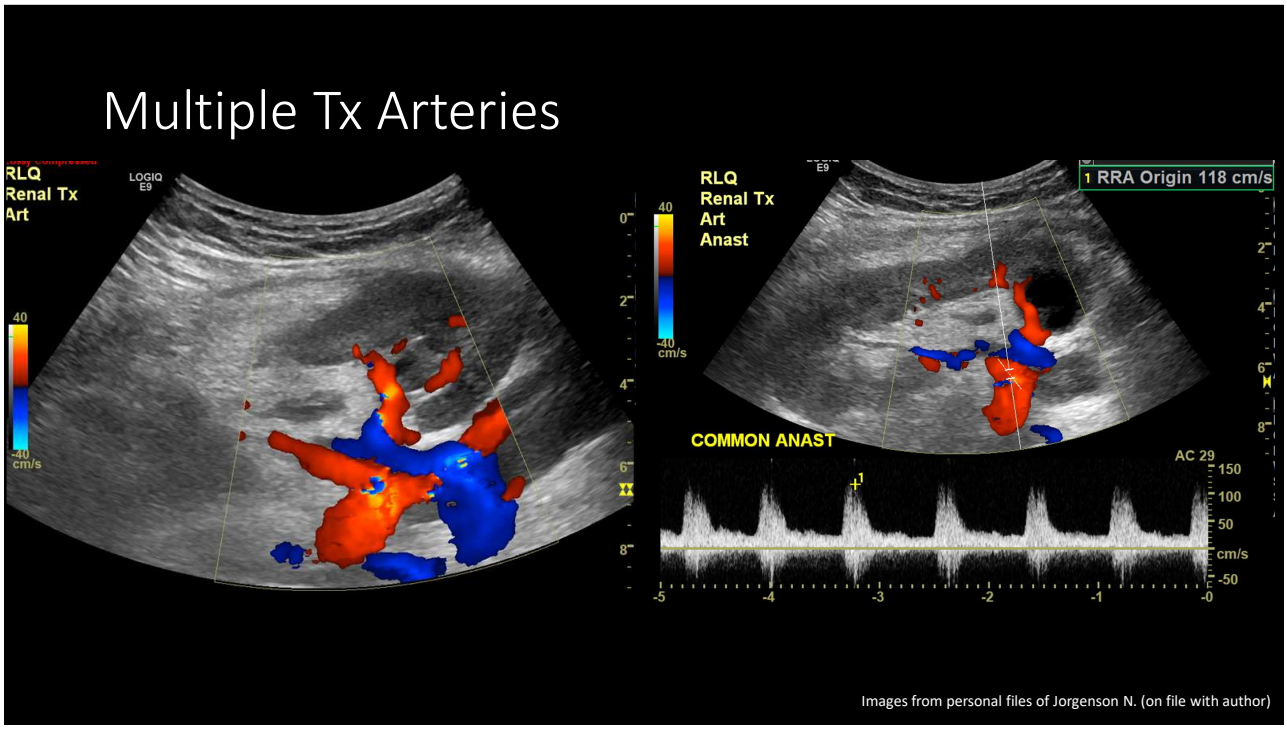

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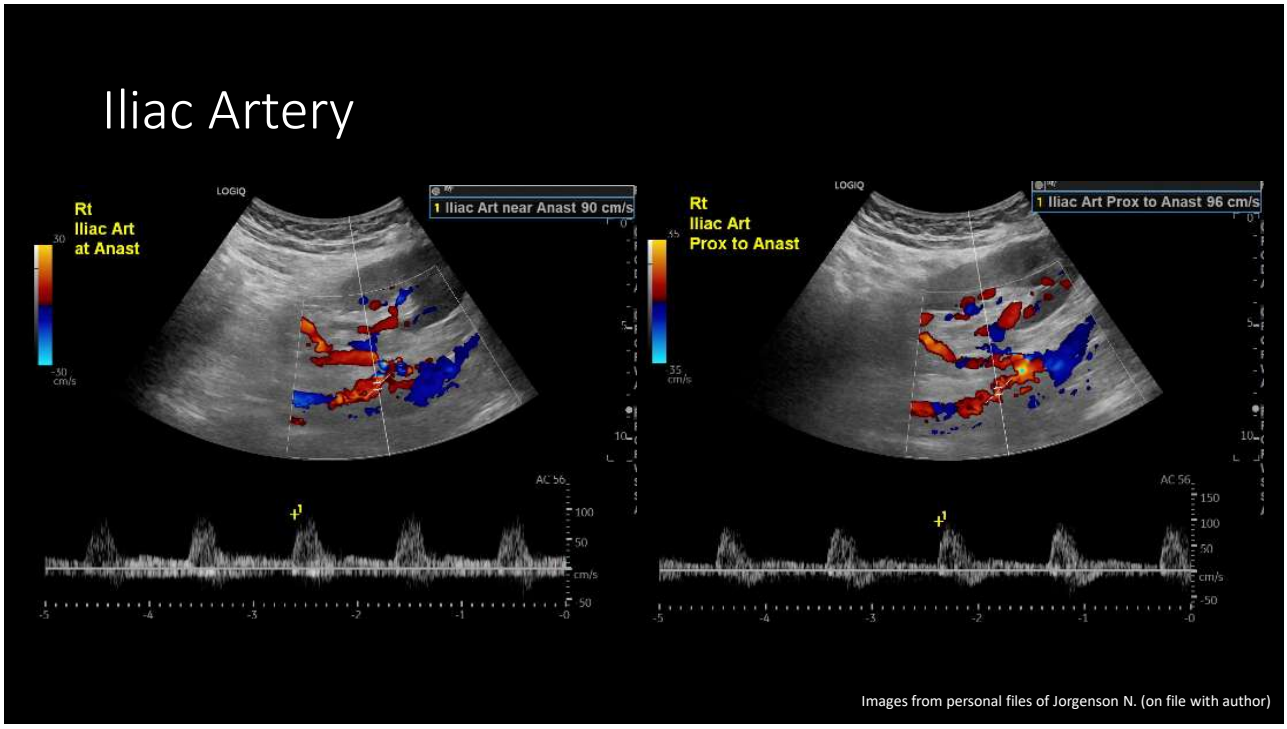

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Tx Artery Velocity Criteria and Renal to Iliac Artery Velocity Ratio (RIR)

- Normal: PSV < 300cm/s and RIR < 3.0
- Possible Stenosis: PSV > 300cm/s **or** RIR > 3.0
- Likely Stenosis: PSV > 300cm/s **and** RIR > 3.0

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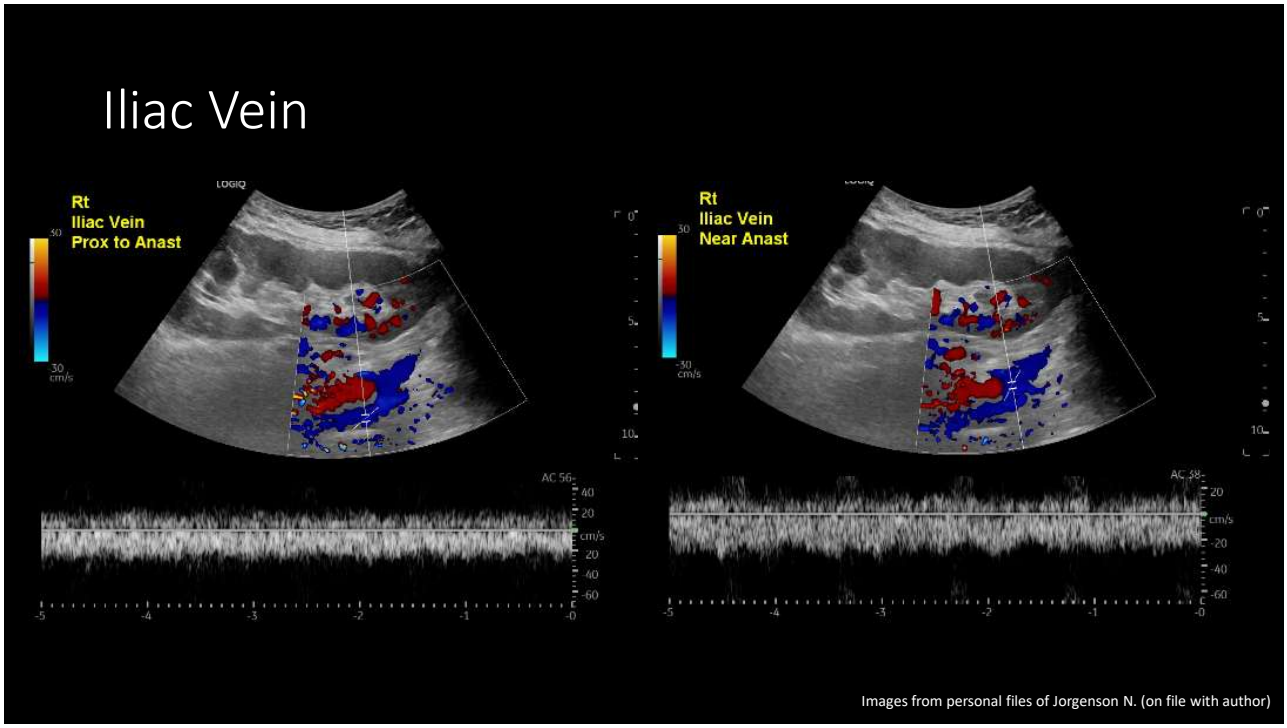
Iliac Vein



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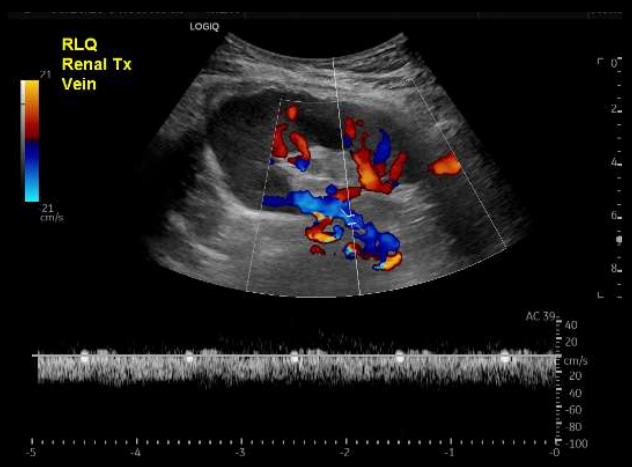
Renal Tx Vein



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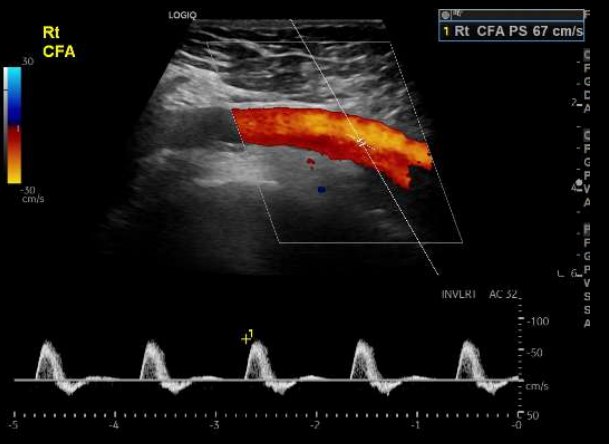
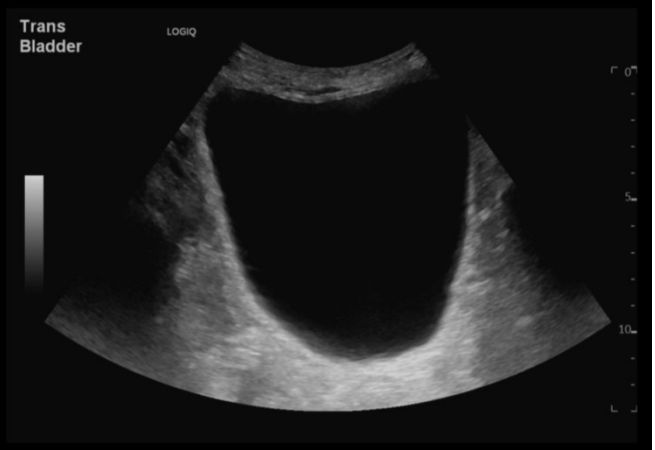
CFA and Bladder





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Case Studies

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Case #1

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Patient History

- 64-year-old male
- End stage renal disease due to global glomerulosclerosis
- Did not have to be on dialysis
- Had a living donor

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Surgery

- RLQ
- One vein
- One ureter
- Two renal arteries sewn into one in a pants-like fashion
- Re-perfusion was slow
- Unsatisfactory pulse in Lt EIA
- Arteriotomy in Lt EIA distal to kidney and clot removed

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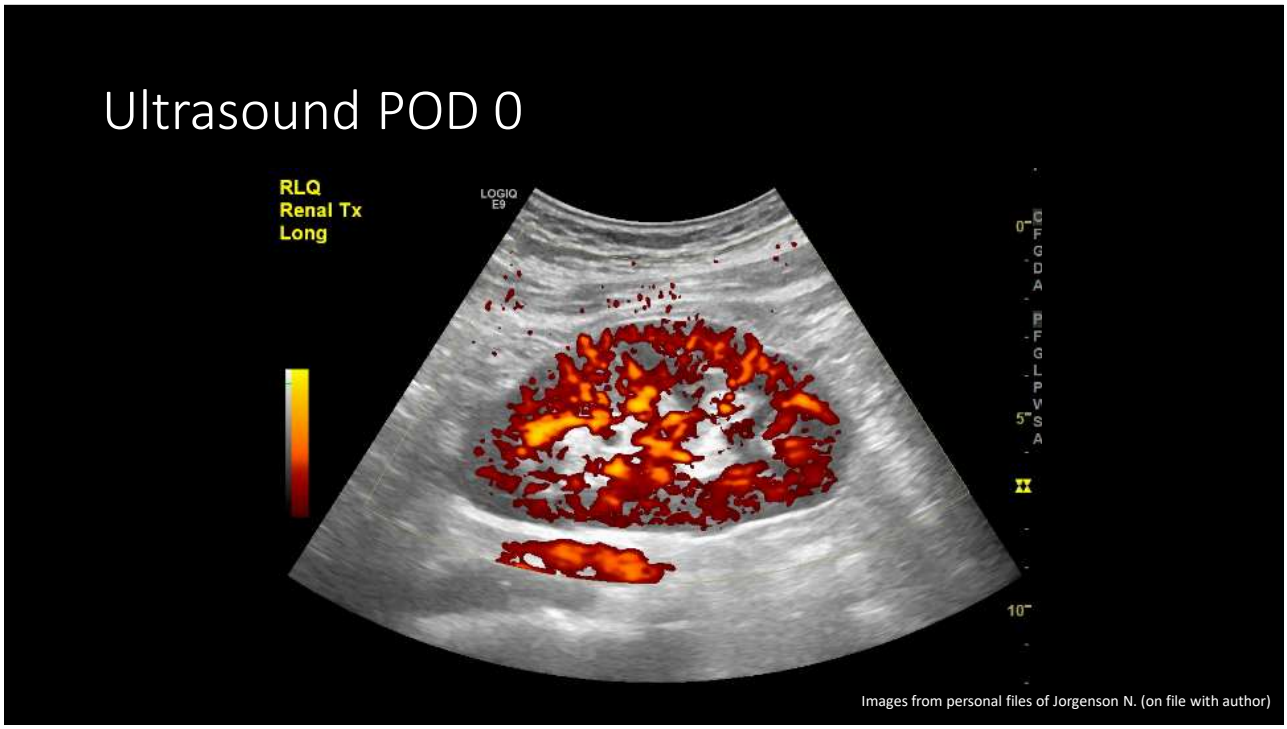

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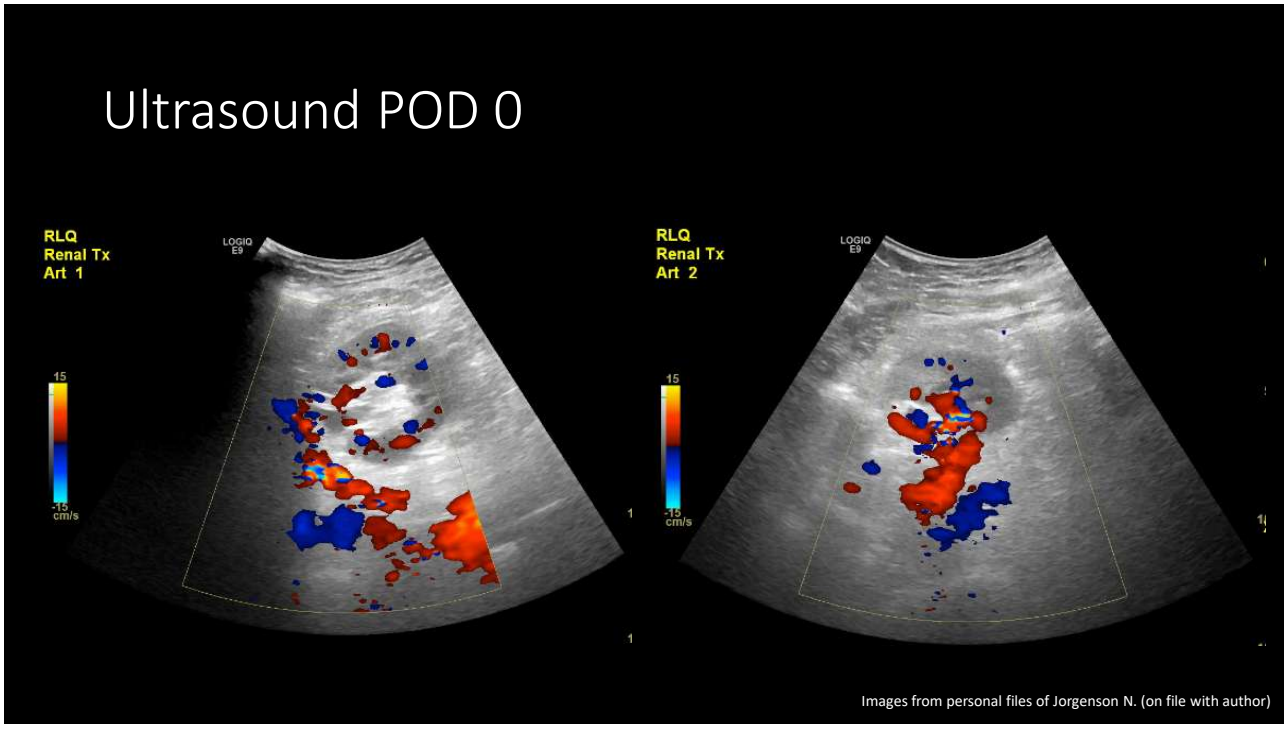

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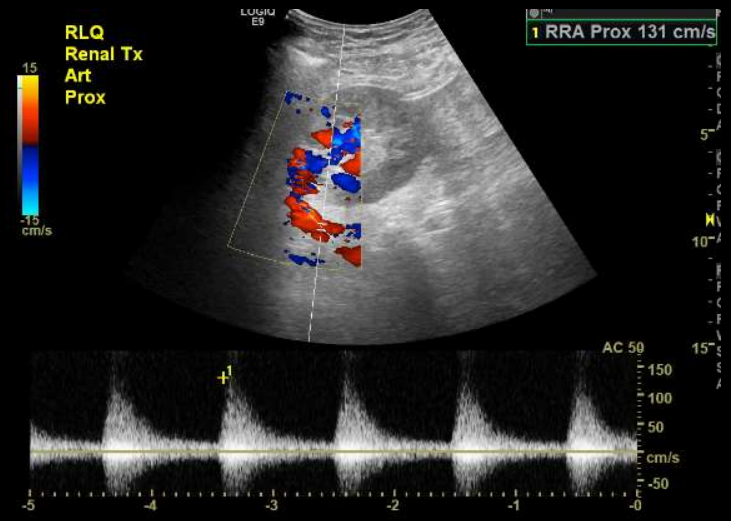
Ultrasound POD 0



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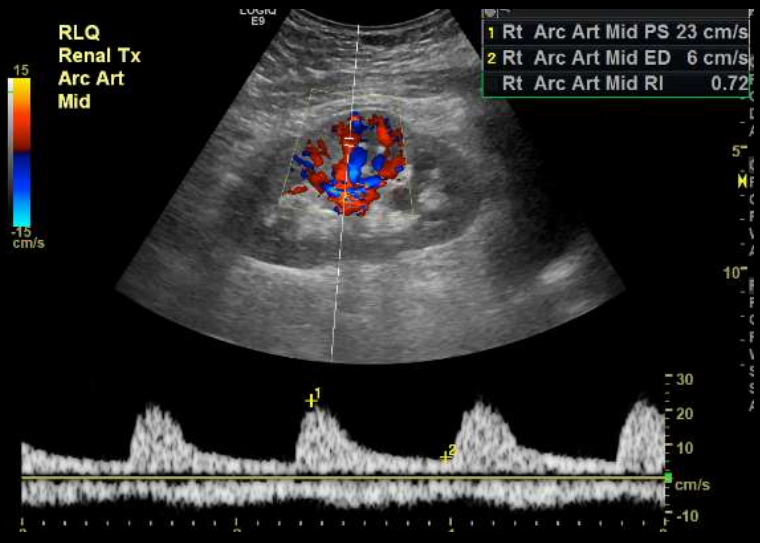
Ultrasound POD 3



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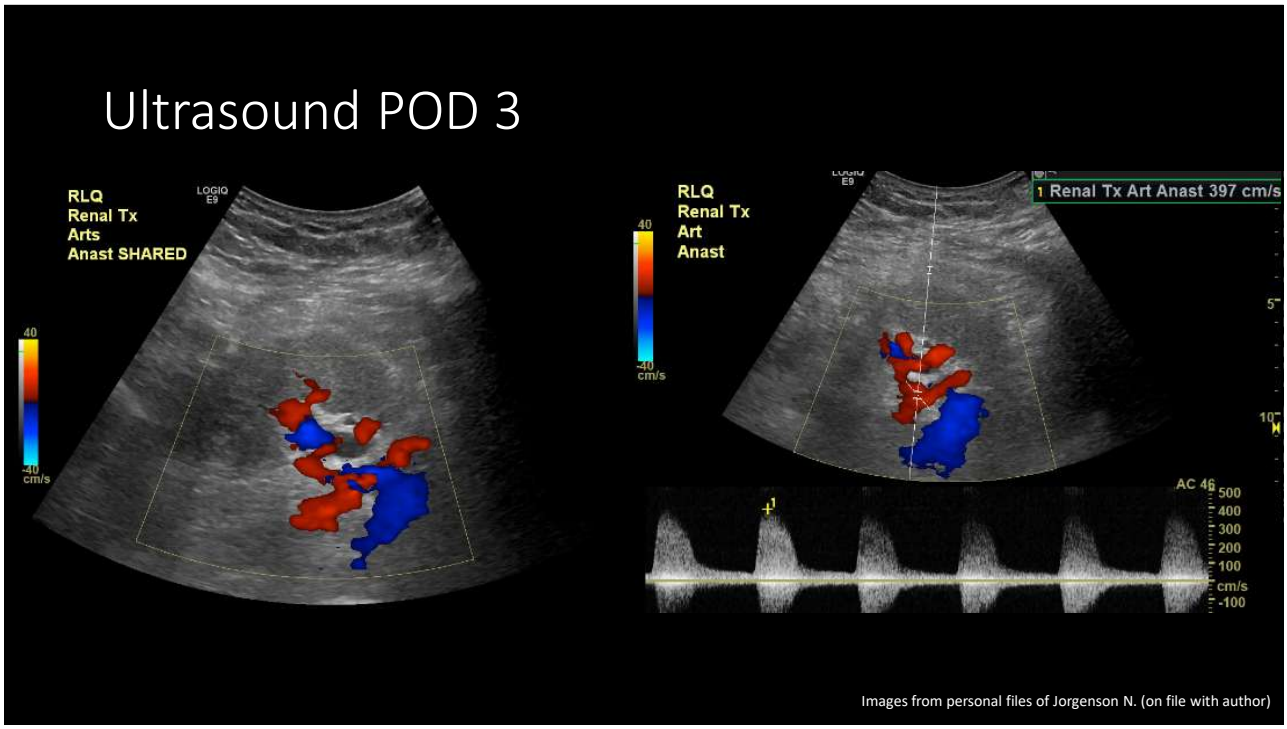

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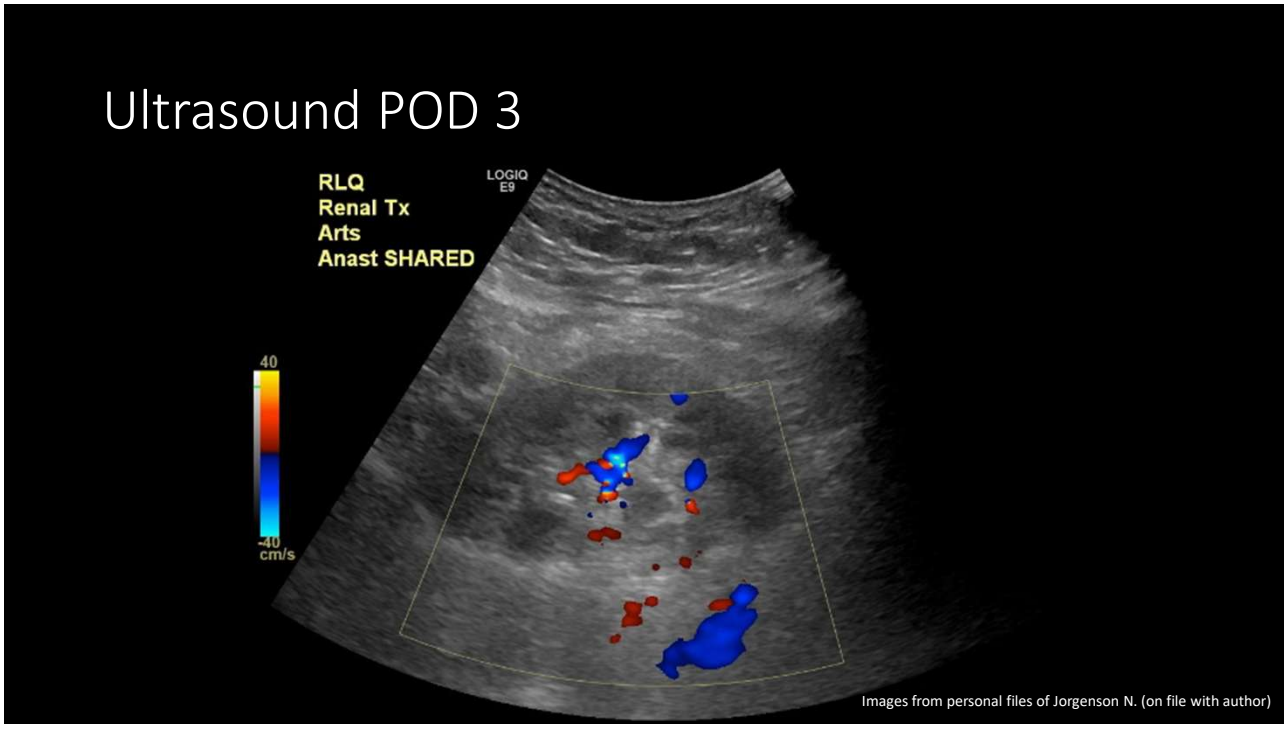

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US-Guided Renal Tx Bx POD 7

- Focal moderate tubulitis and mild interstitial inflammation
- Acute tubular injury
- Focal moderate arteriosclerosis
- Meets criteria for borderline rejection

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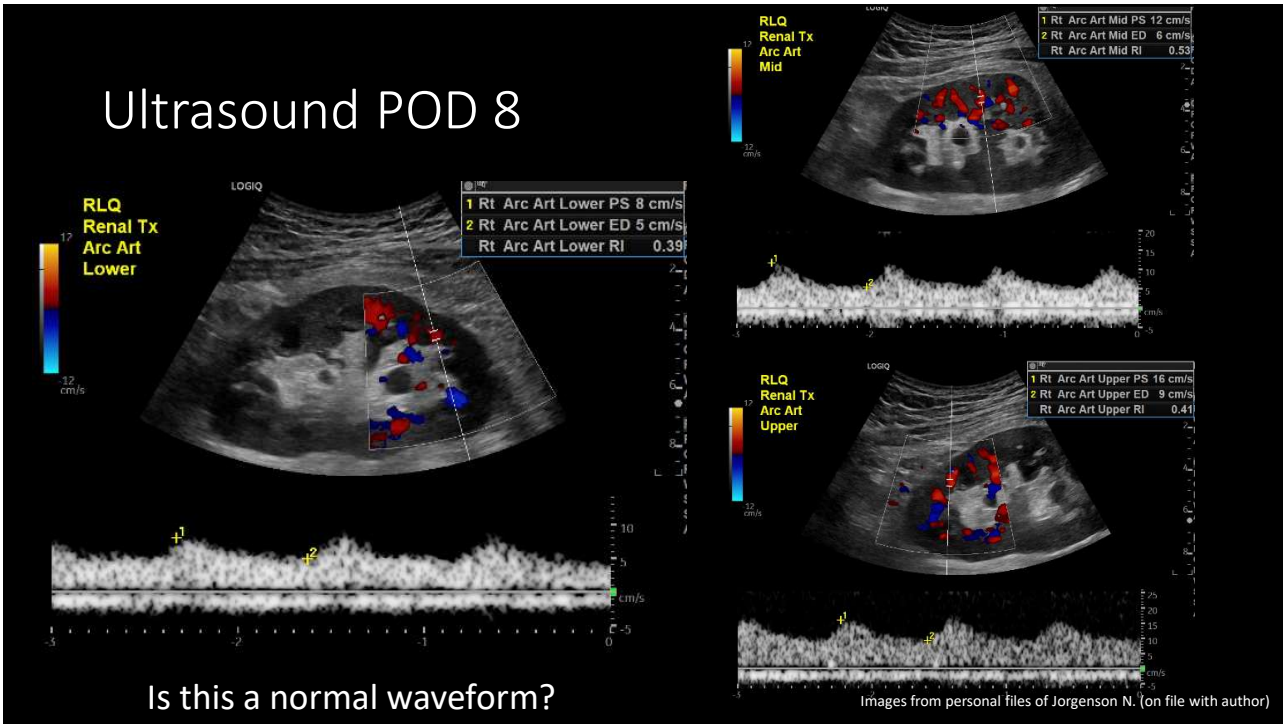
Ultrasound POD 8



Is this a normal waveform?

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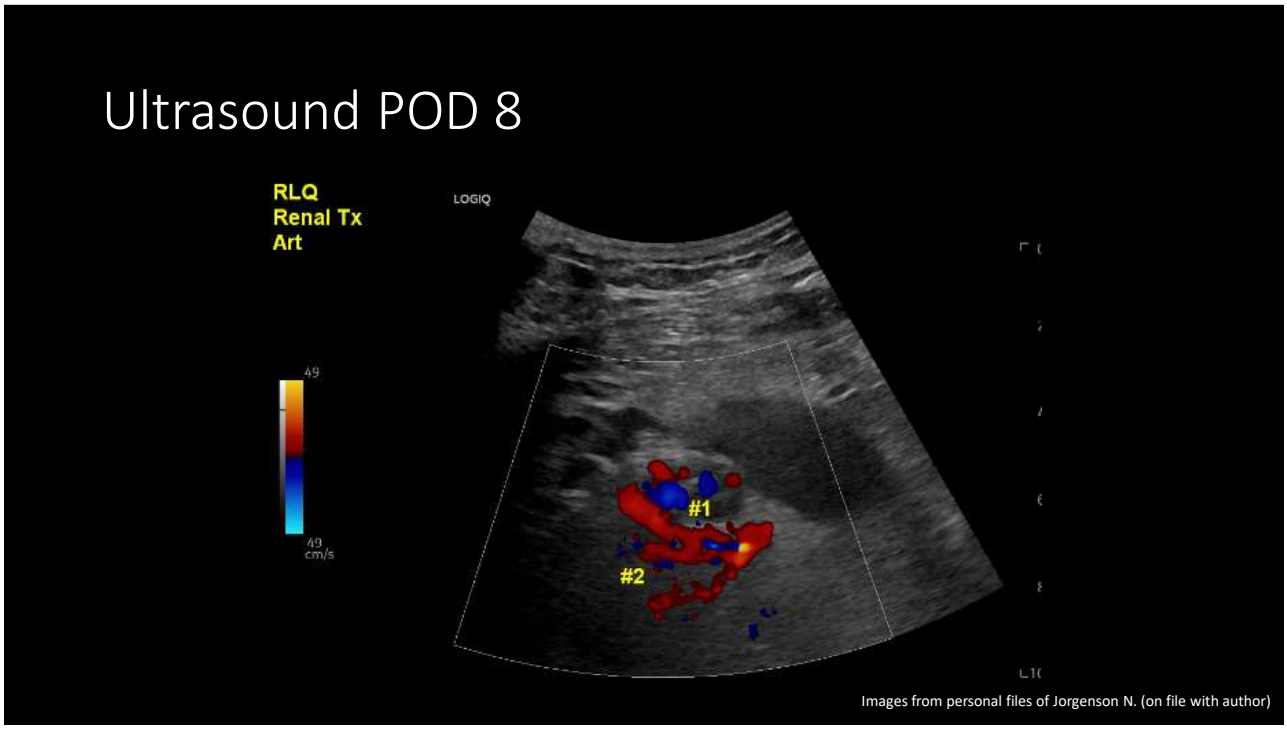
Ultrasound POD 8



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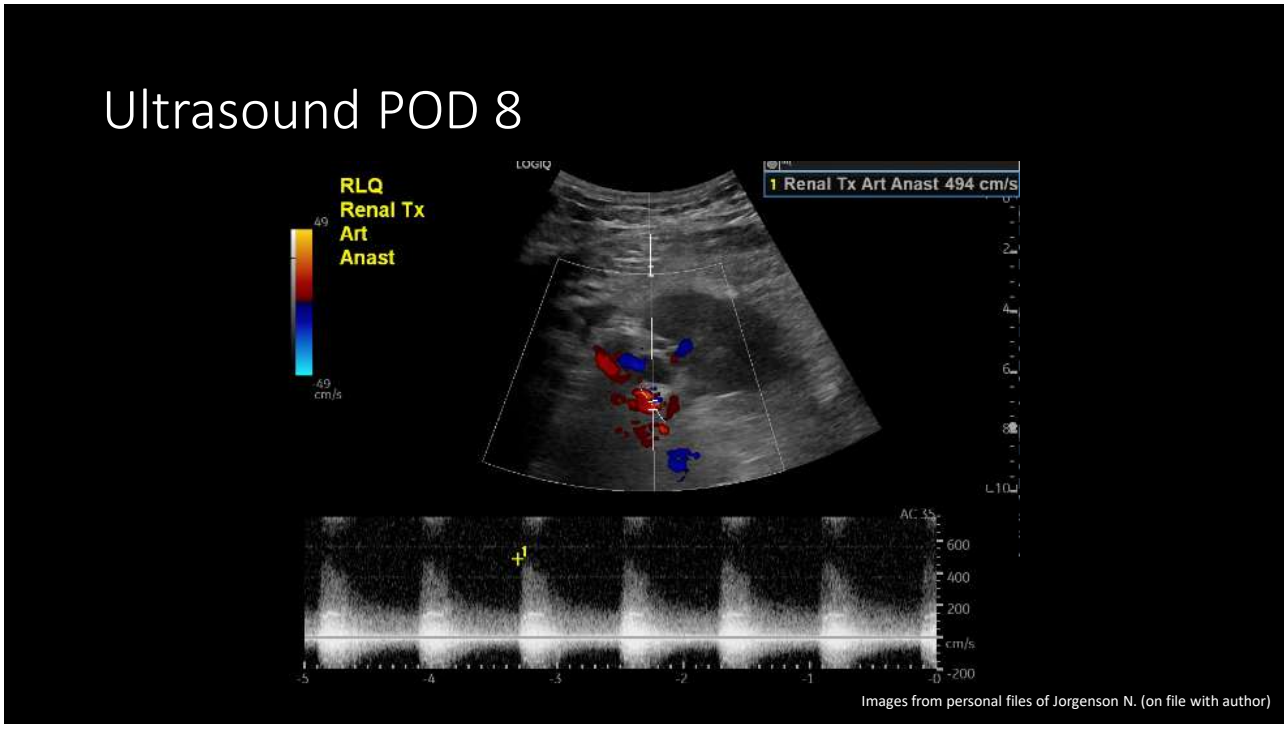
Ultrasound POD 8



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Bring Back Surgery POD 9

- Renal arteries were patent, but short and small
- Kidney had rotated medially
  - Surgeons rotated it back laterally to improve blood flow
- Intraoperative US confirmed lower velocities
- Kidney tacked in place

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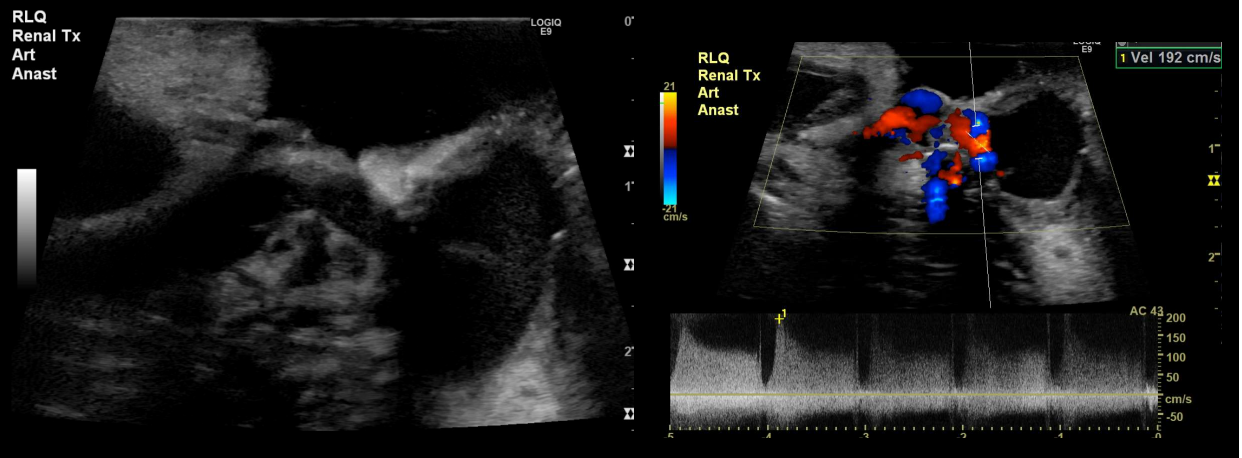
Intraoperative Ultrasound



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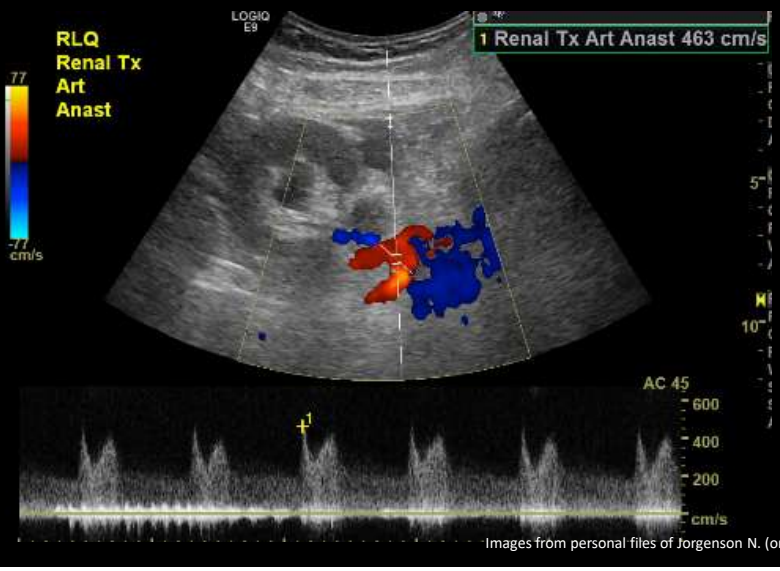
Ultrasound POD 10

- Only one artery seen
- High velocity again
- Borderline RIs



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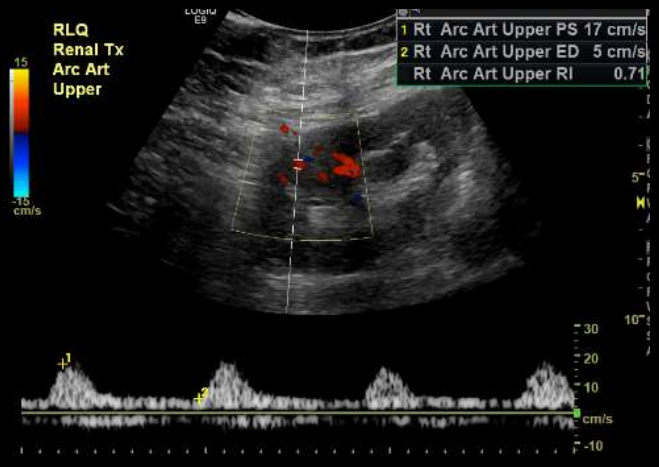
Ultrasound POD 11



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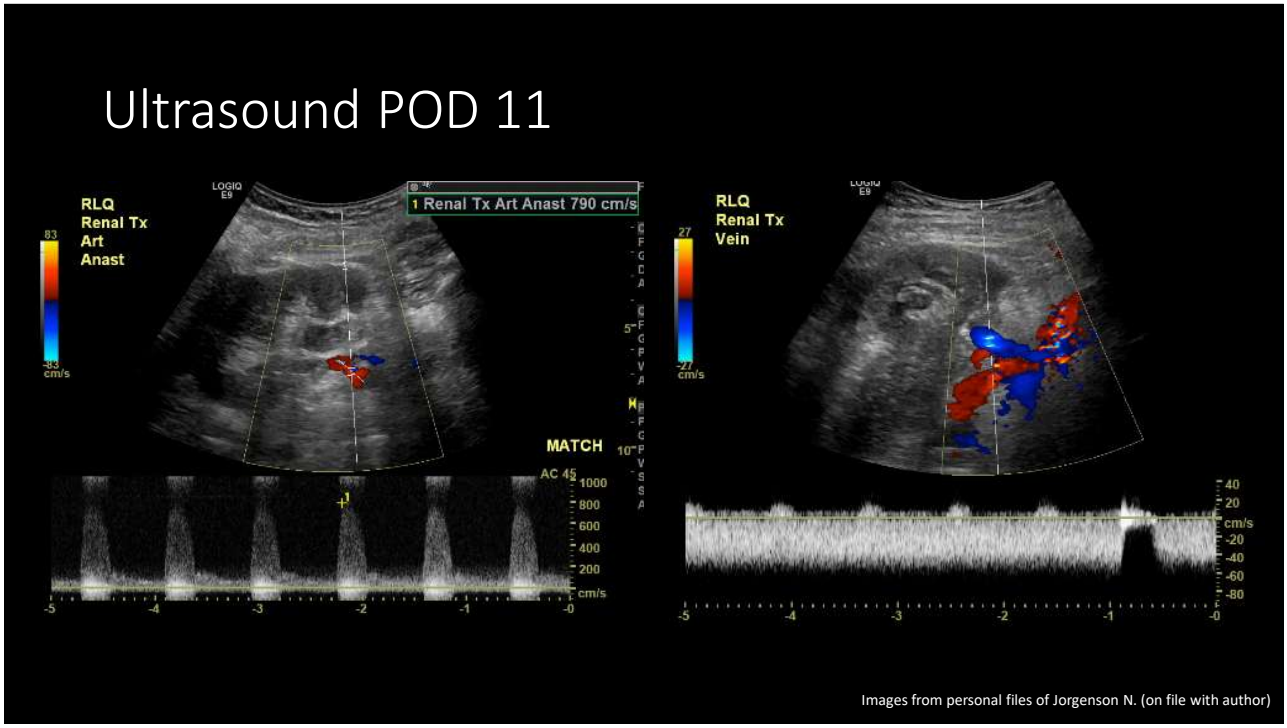
Ultrasound POD 11



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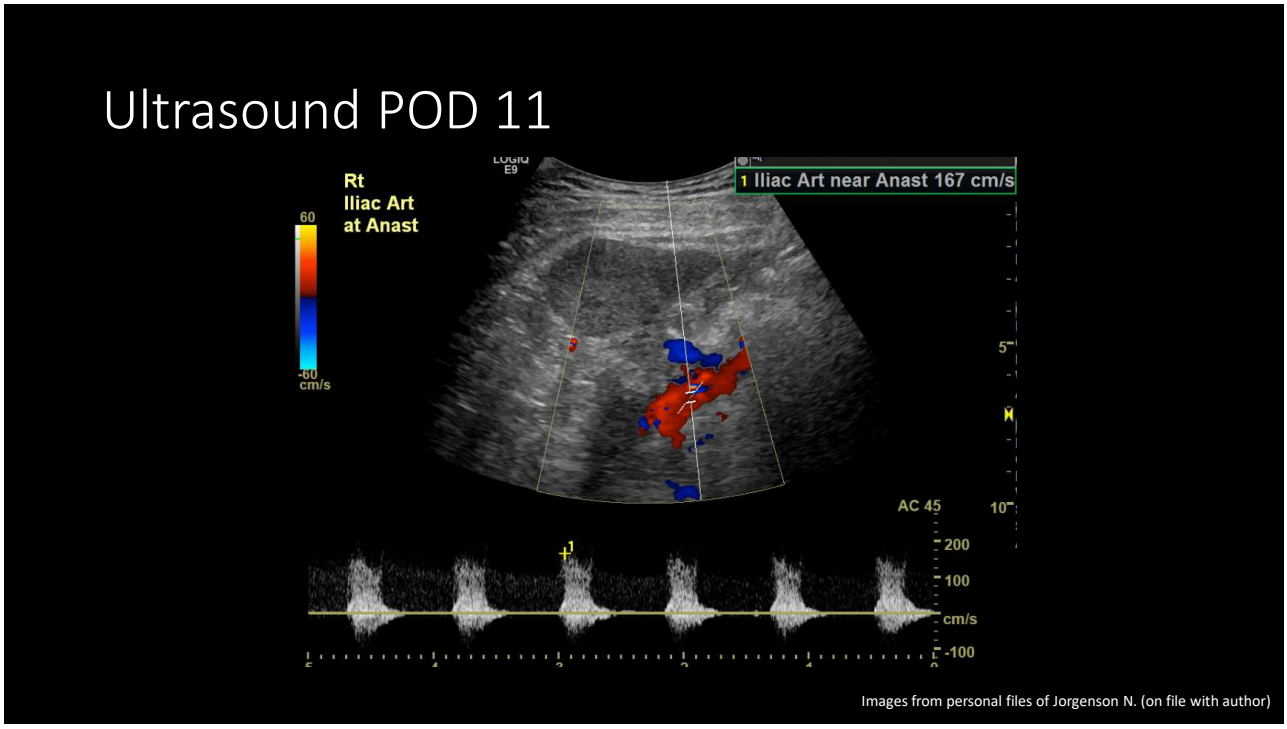
Ultrasound POD 11



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IR POD 11

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IR POD 11

- Complex dissection of the right external iliac artery
- Severe anastomotic stenosis of the primary renal artery of the RLQ renal transplant
- 2nd transplant artery is poorly delineated, diminutive in caliber, and not amenable to revascularization
- Plan was to maintain the patient on low intensity heparin through the remainder of the weekend with plan to intervene on the small primary transplant renal artery with a drug eluting coronary artery stent if possible

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IR POD 13

Stent placement in dominant tx artery

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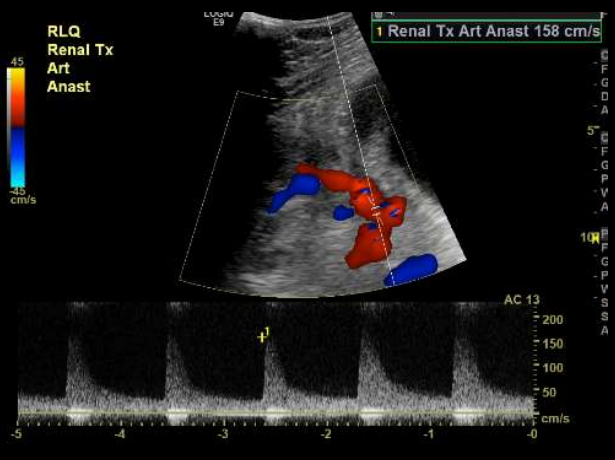
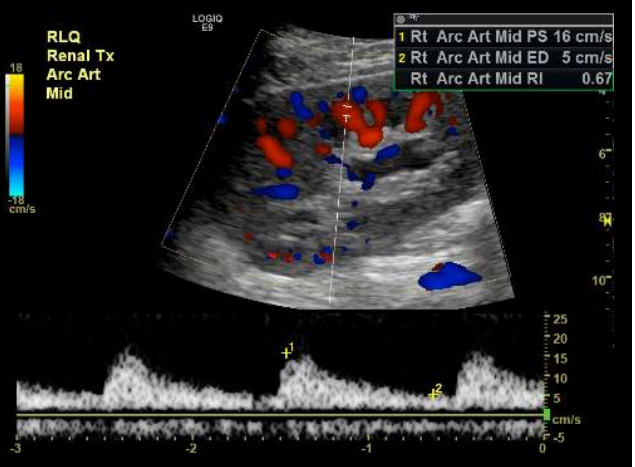
US POD 14





Images from personal files of Jorgenson N. (on file with author)

56

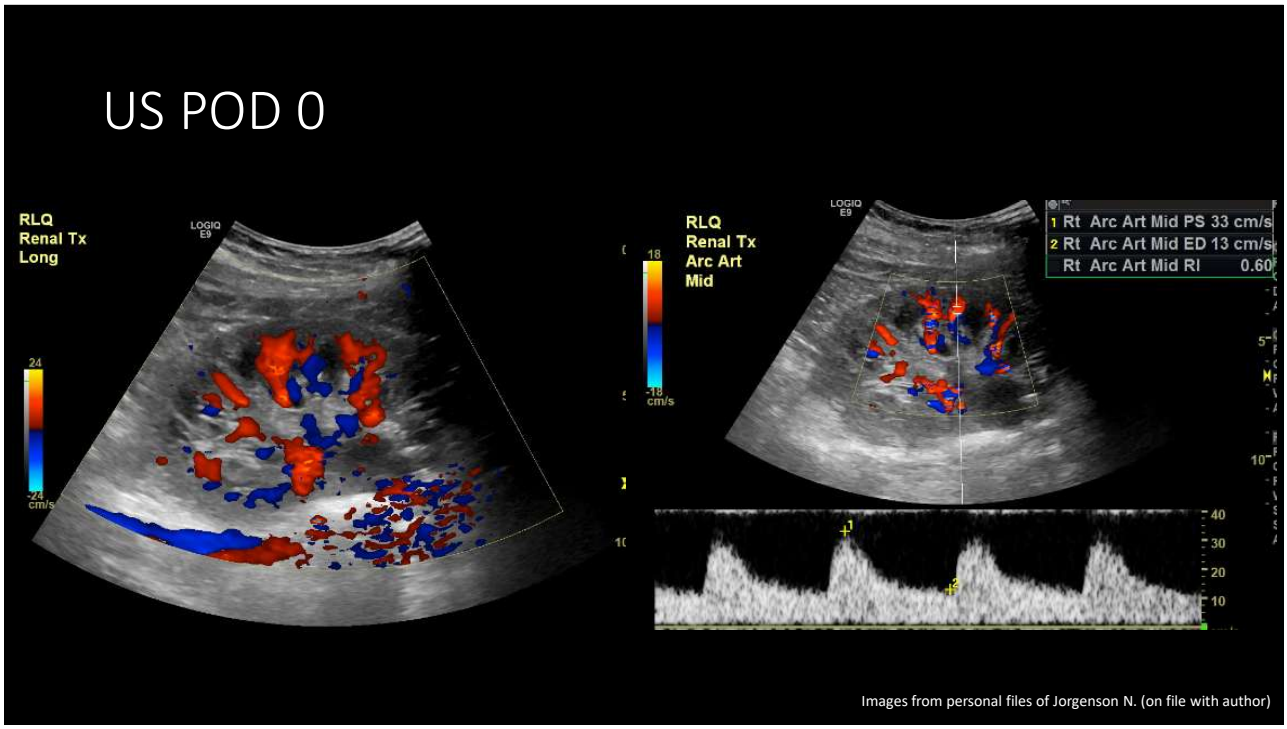
Case #2

57

Patient History

- 21-year-old male
- ESRD due to IgA nephropathy
- One artery and one vein in tx

58



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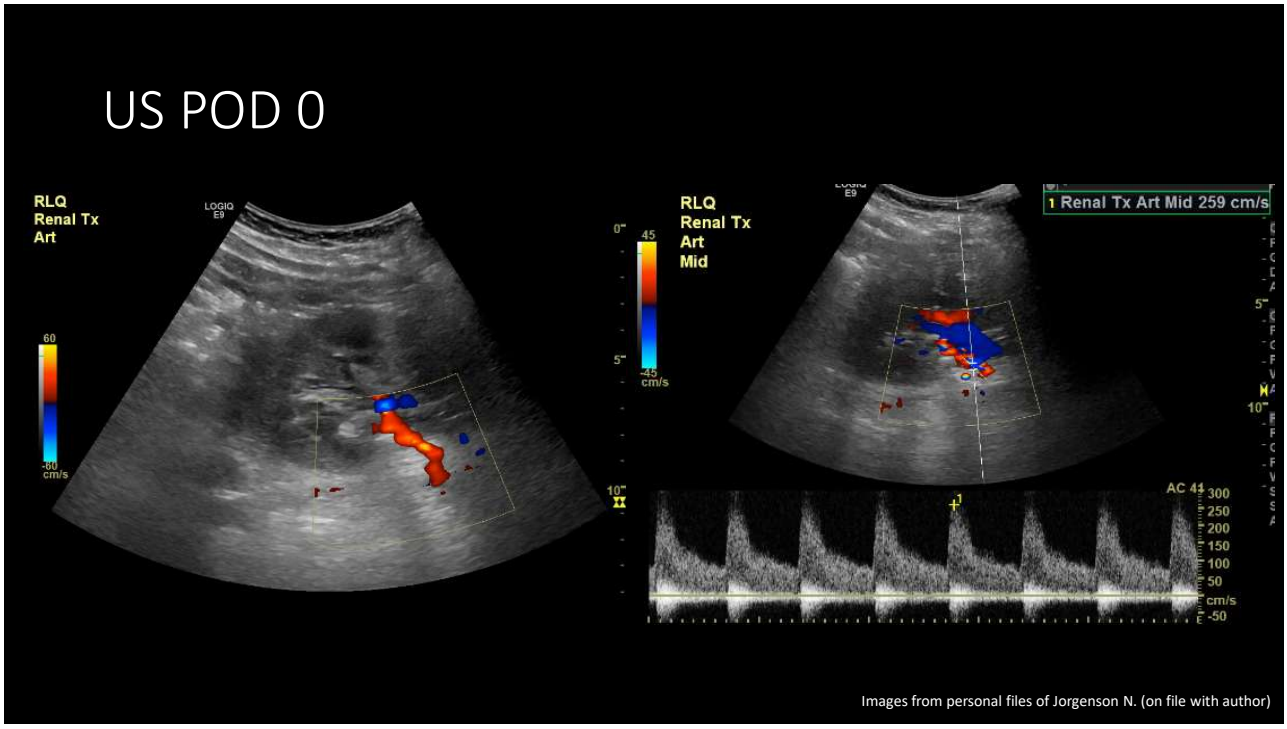

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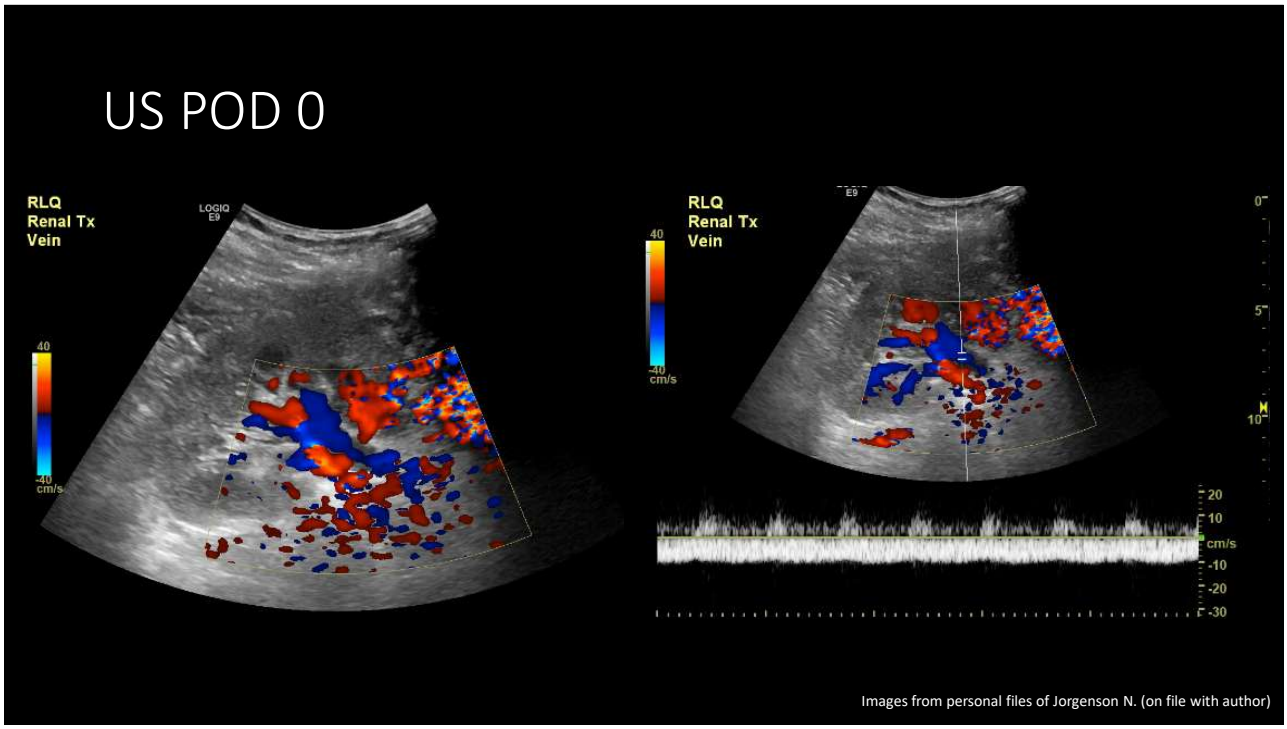

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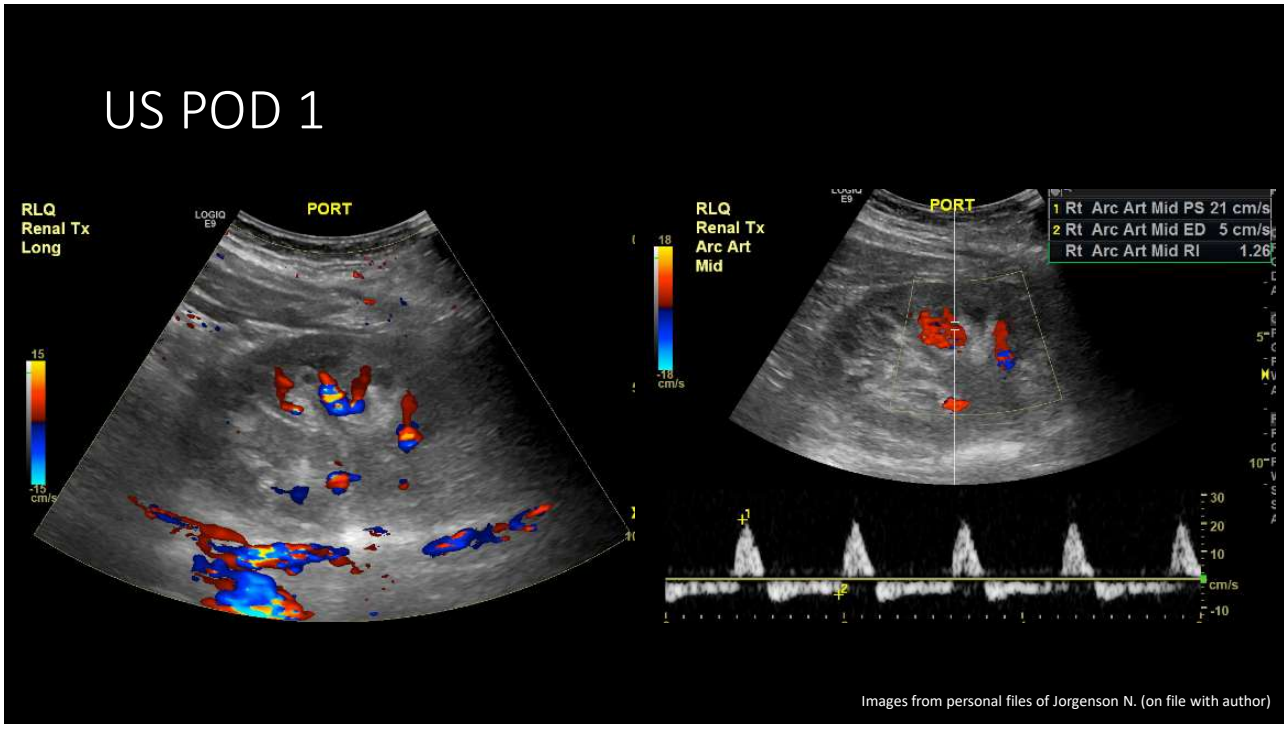
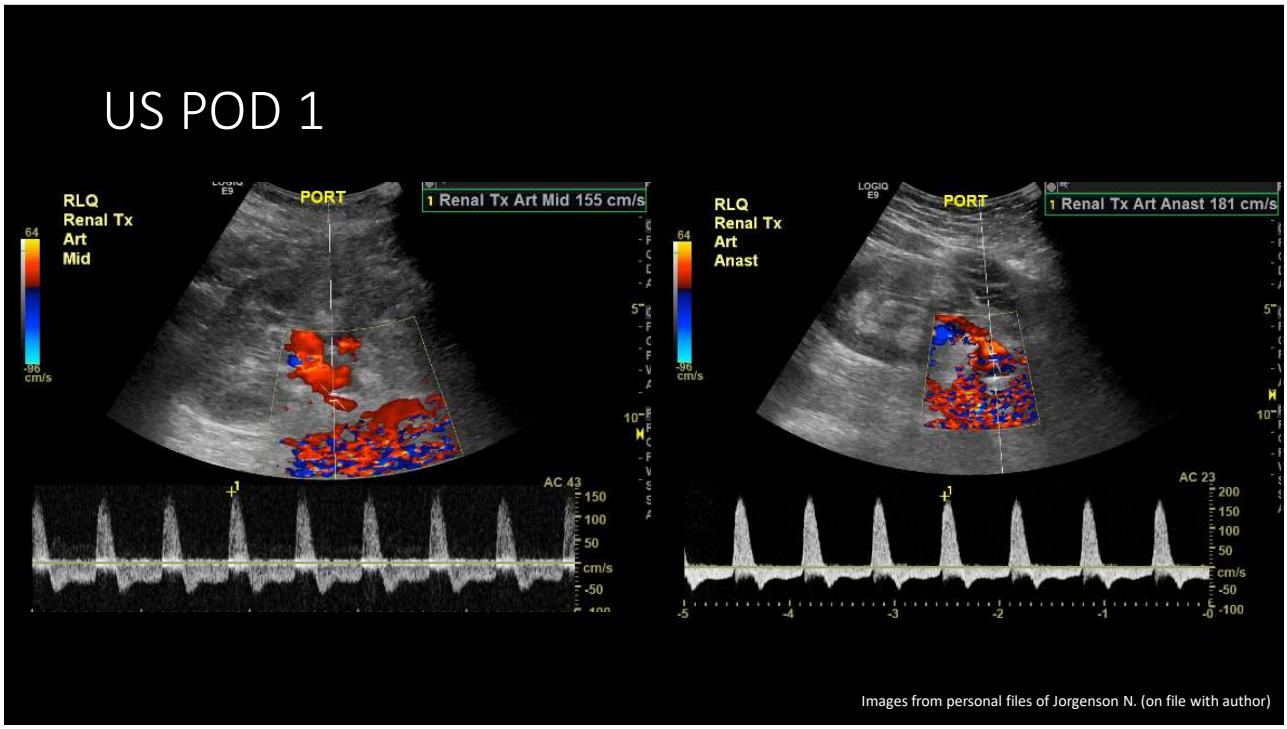


62

US POD 1



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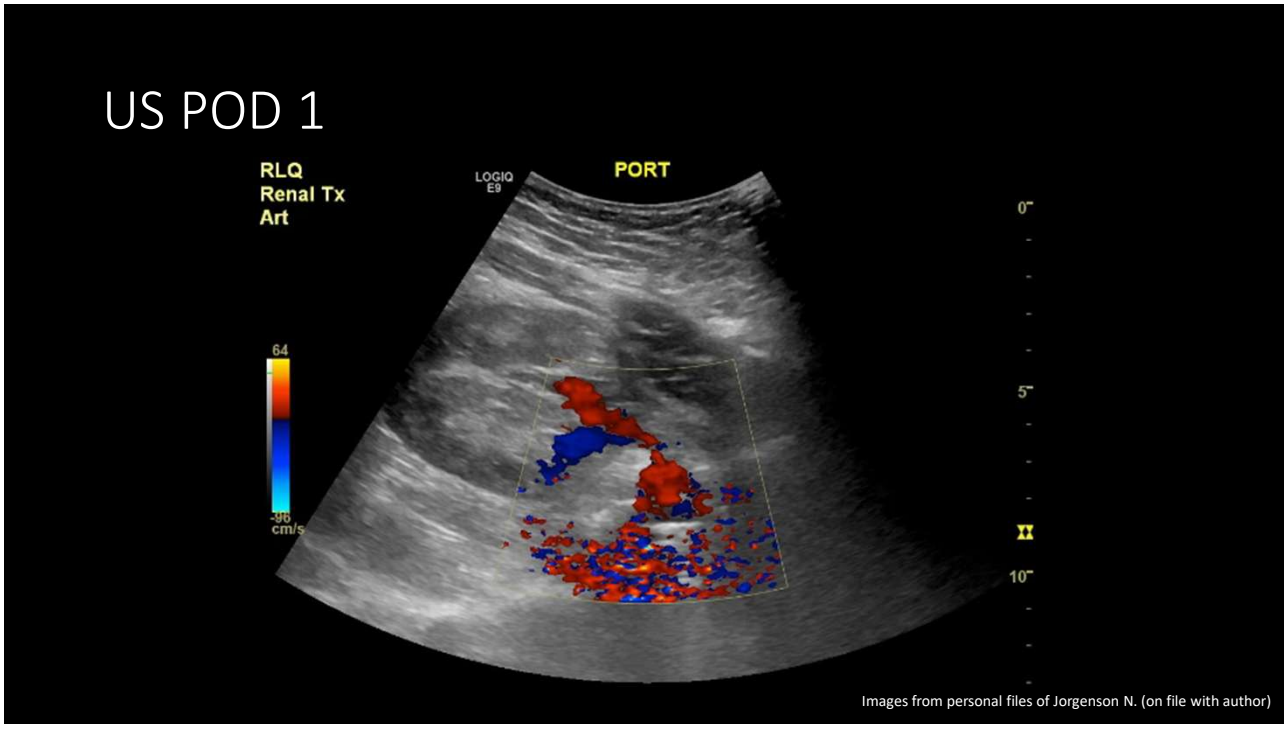
63

US POD 1



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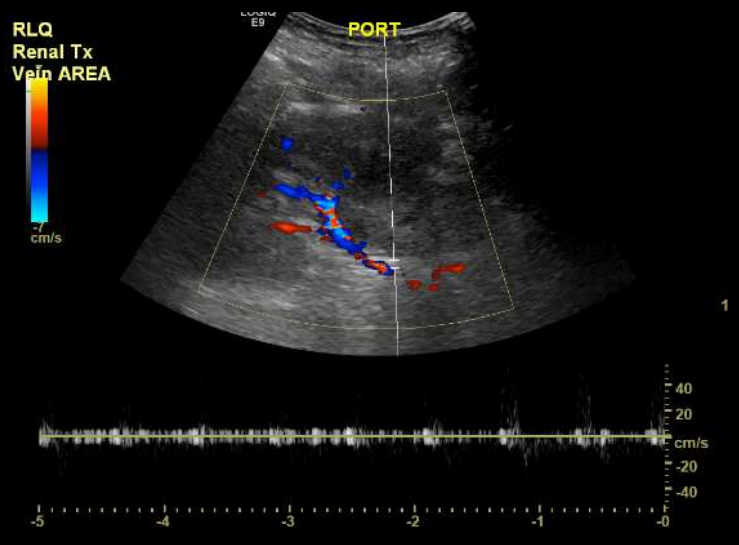
64

Any guesses on what is going on?

65

US POD 1



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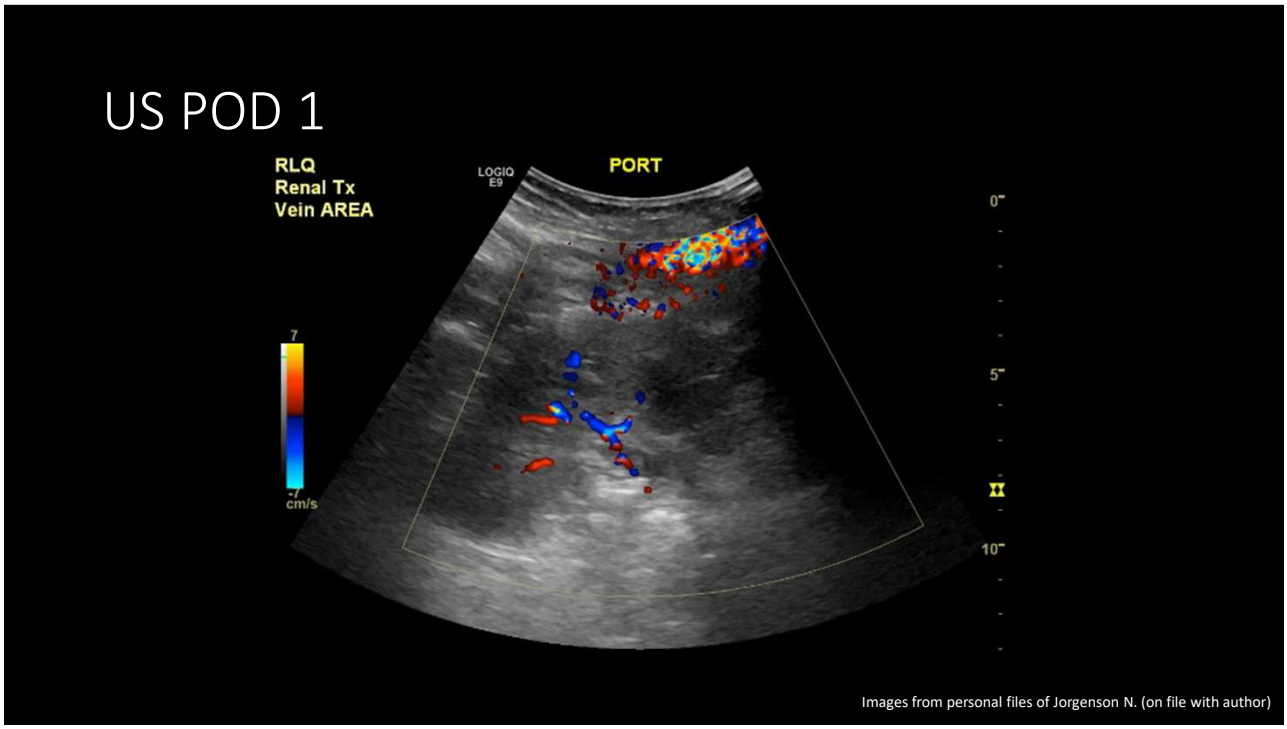

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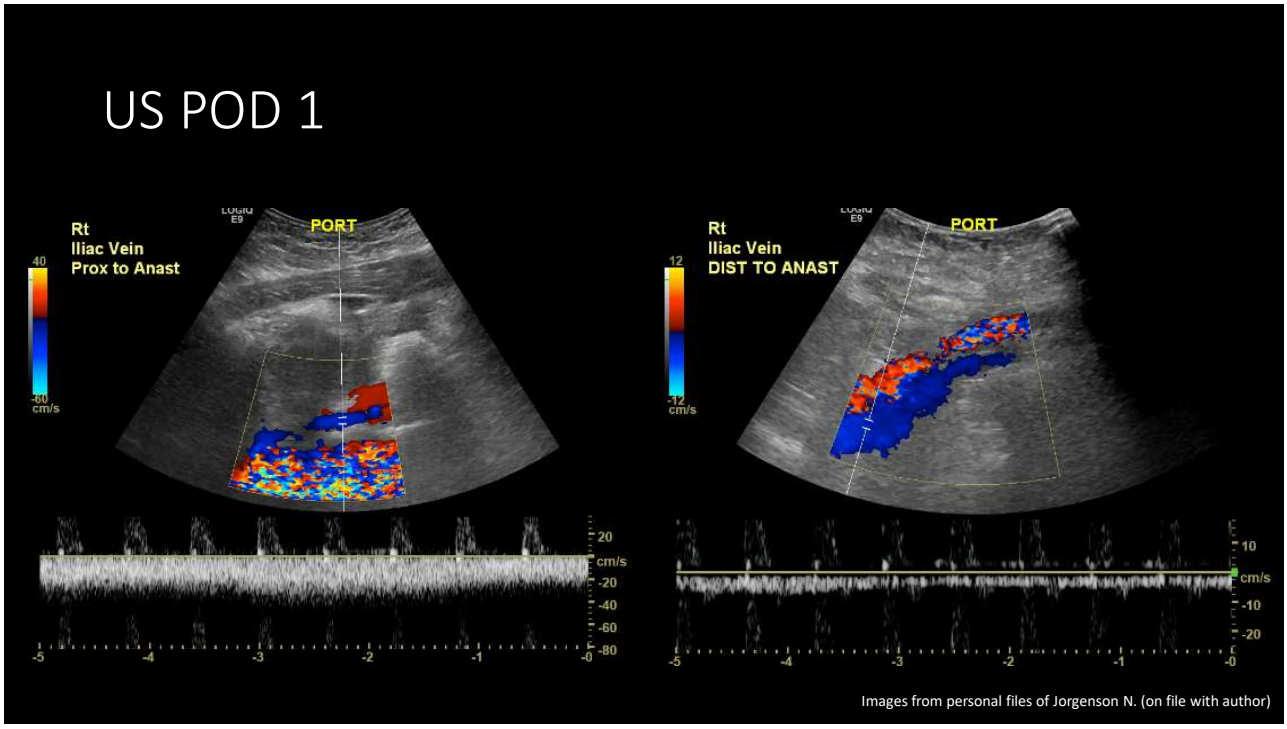


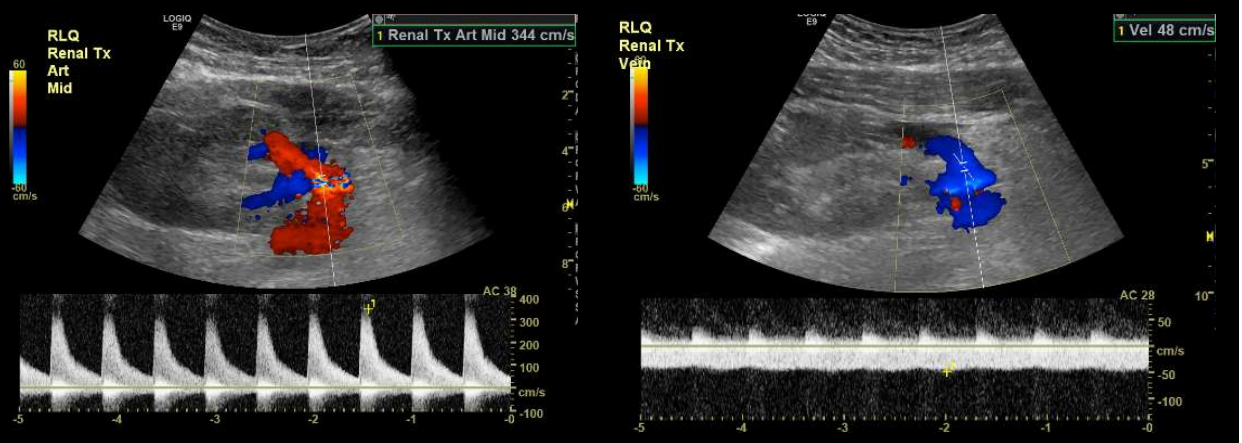
68

Bring Back to OR

- Renal vein was thrombosed back up into kidney
- Excised the clot and then gave heparin
- Kidney perfused well and pink

69

US after surgery (same day as last US)



Elevated artery probably due to postop edema

Images from personal files of Jorgenson N. (on file with author)

70

Follow-up

- Unfortunately, patient had primary allograft failure and was listed for another transplant
- Patient got a new tx 8 months later!
- He is doing well

71

Case #3

72

Patient History

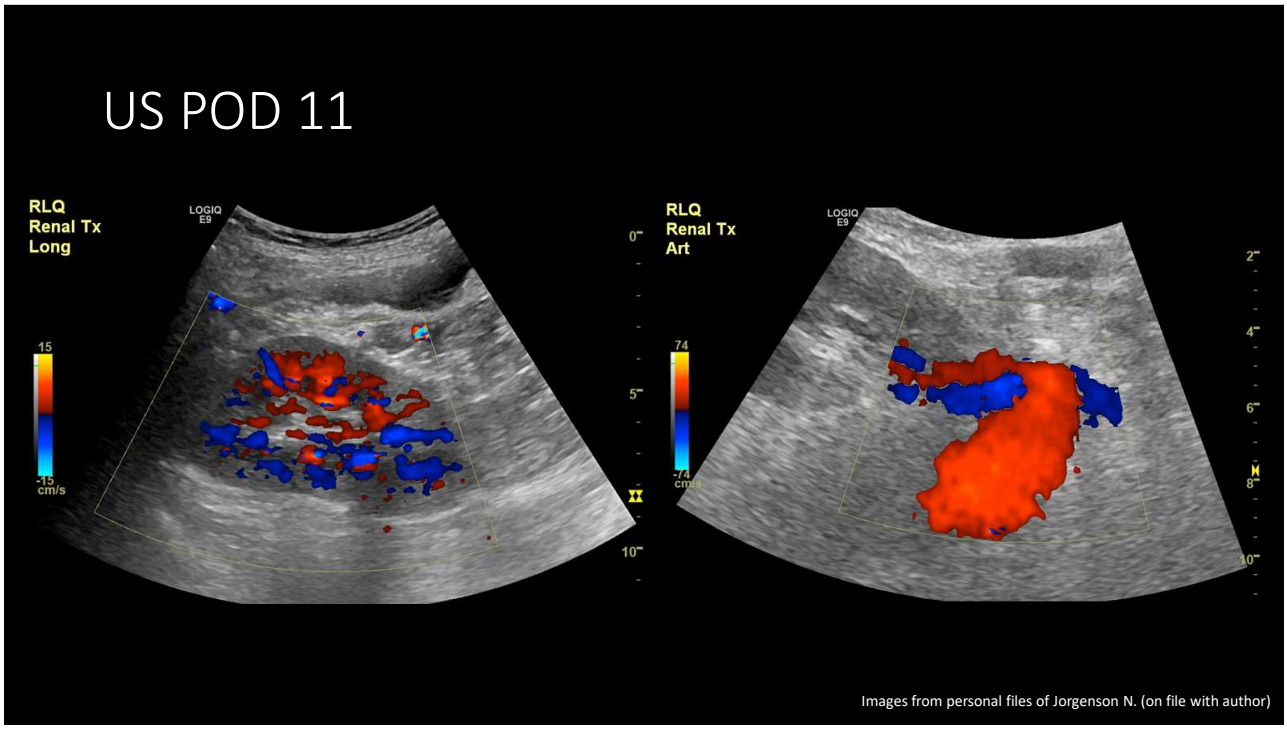
- 59-year-old man
- Stage 5 chronic kidney disease due to ADPKD
- Deceased donor tx
- One renal artery, one renal vein
- Surgery and immediate post op US looked good

73

POD 11

- Newly distended abdomen
- Acute kidney injury
- Slow graft function

74



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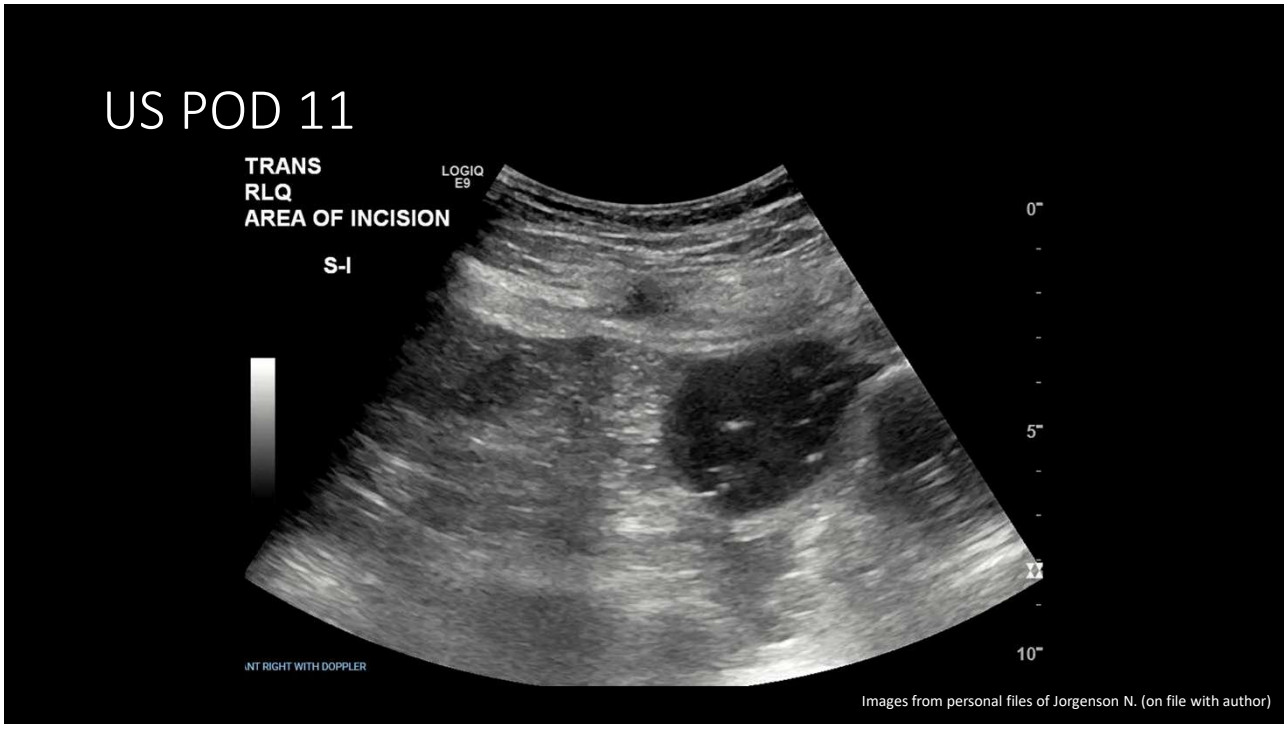

76

What are we seeing here?

77

US POD 11

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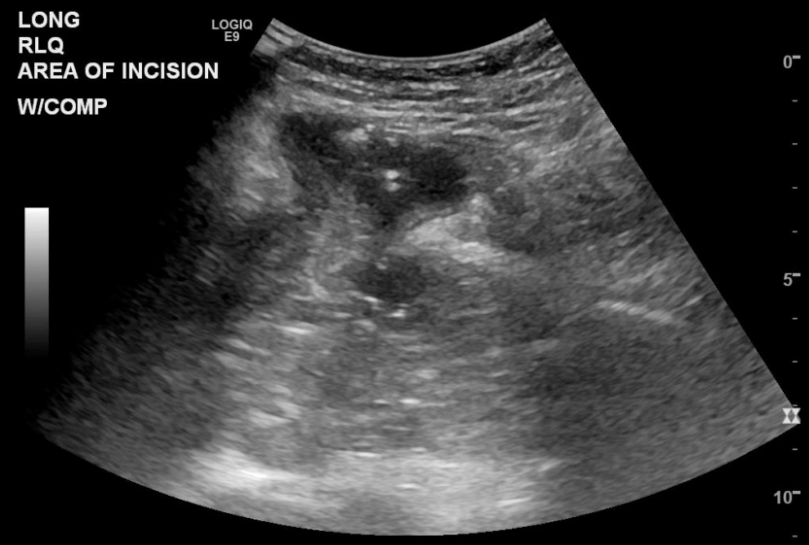
78

US POD 11



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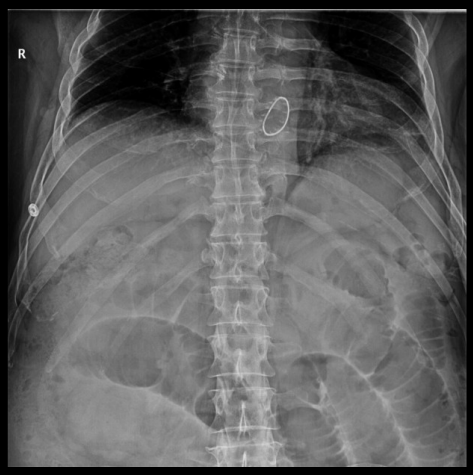
X-ray from earlier that day



"Multiple dilated loops of small bowel are worrisome for small bowel obstruction"

Images from personal files of Jorgenson N. (on file with author)

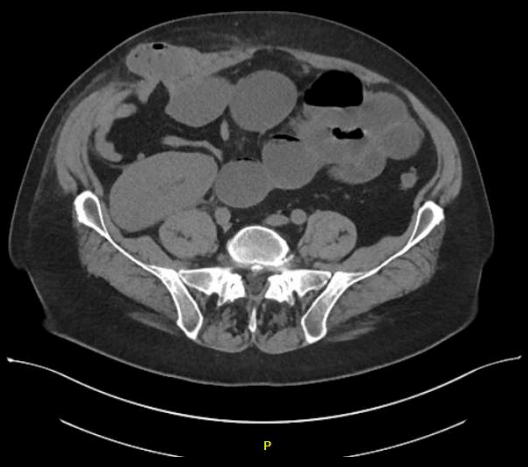
80

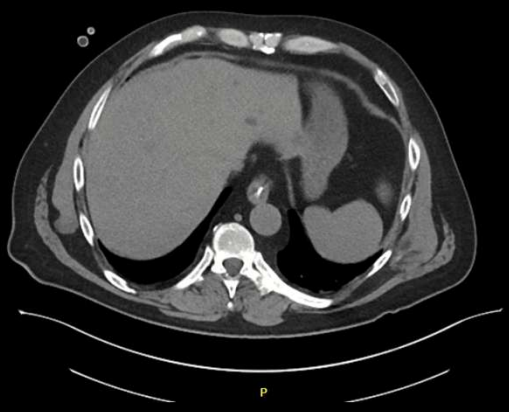
Ultrasound Report

- Incisional hernia incidentally noted
- Hernia contains loops of bowel
- Likely cause of small bowel obstruction

81

CT





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82

Surgery the same day

- Loop of bowel was found to be herniated through the superior part of the transplant incision
- The herniated bowel was viable
- Two small serosal tears were repaired

83

Case #4

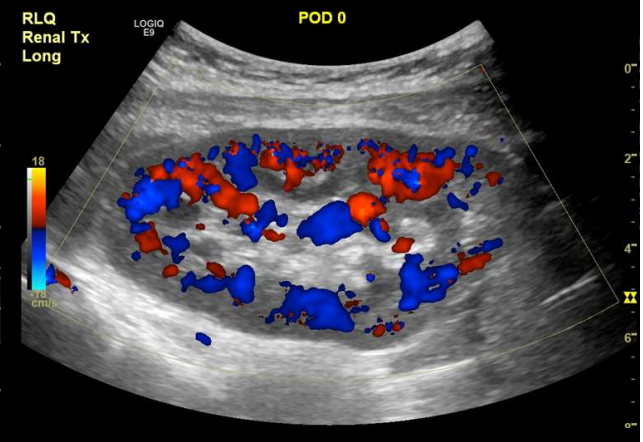
84

Patient History

- 37-year-old
- End stage kidney disease due to IgA nephropathy
- Recipient of living donor kidney transplant
- Donor kidney had two arteries that were anastomosed side to side into one conduit
- Recent removal of foley and ureteral stent—soon after patient stopped making urine and developed abdominal pain

85

US POD 0



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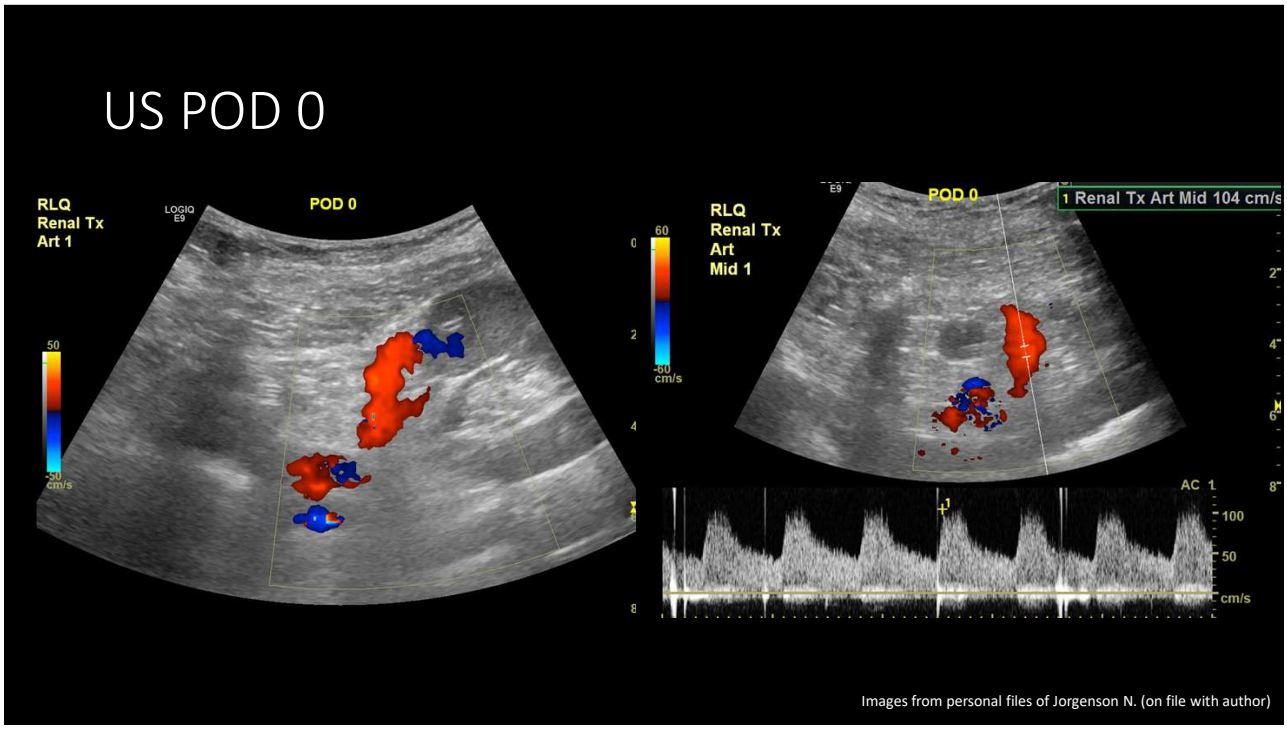
86



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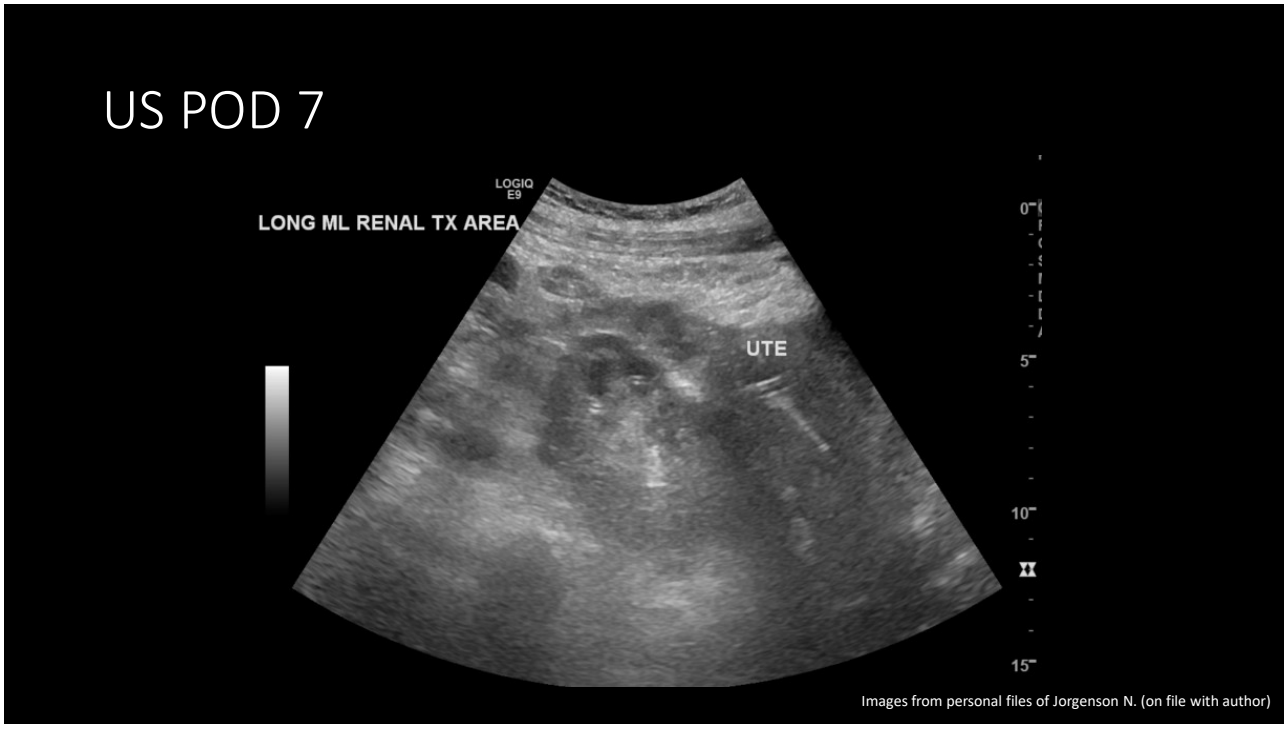

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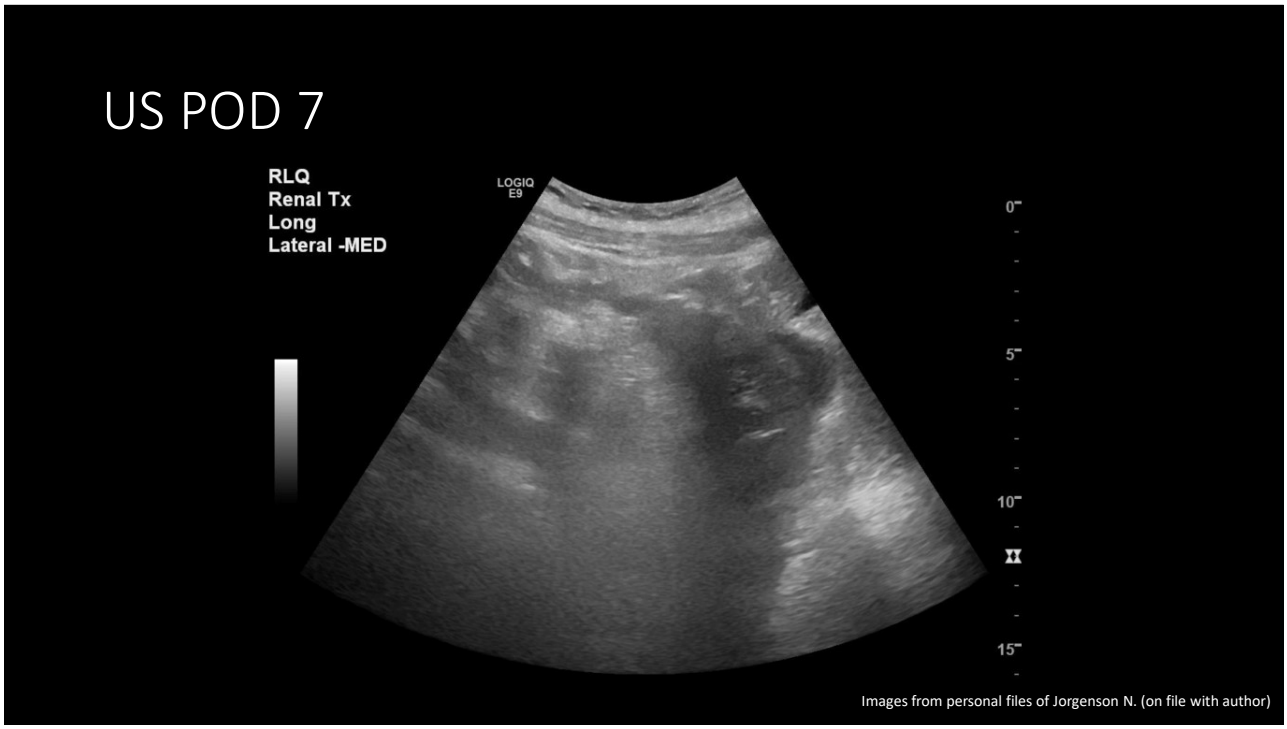

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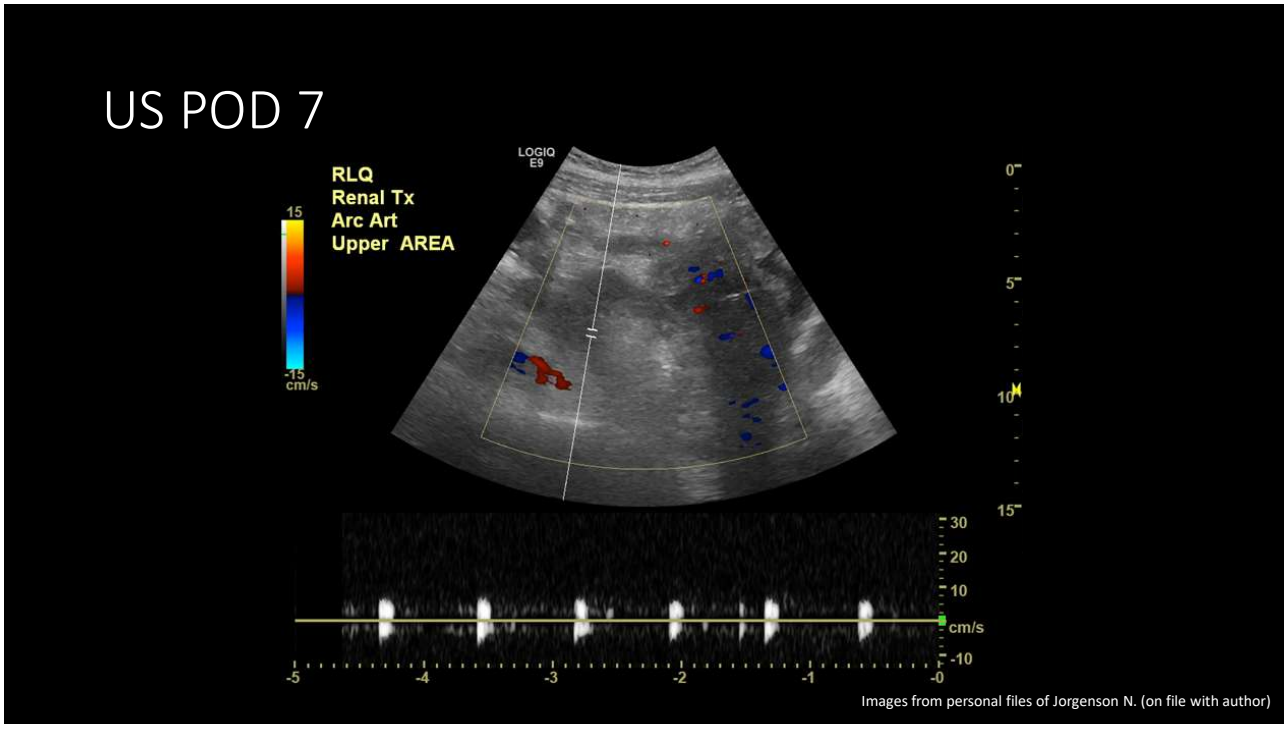

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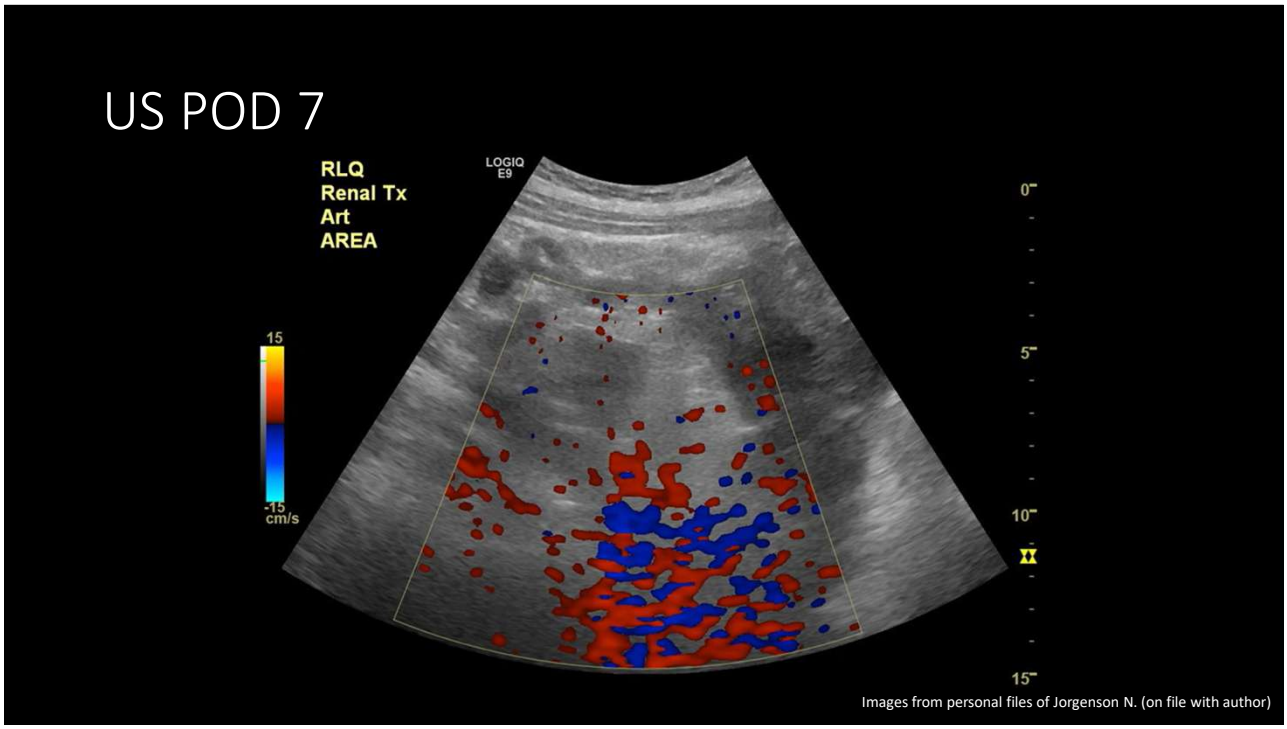
US POD 7



91

Same day surgery

- Tx kidney had ripped through the stay stitch and moved medially
- Twisted and torsed around ureter
- Renal artery and vein thrombosis
- Attempted to restore blood flow to kidney, but appeared non-viable due to greater than 24 hours without flow.
- Tx was removed and hemodialysis catheter was placed
- Re-listed for tx and is still waiting

92

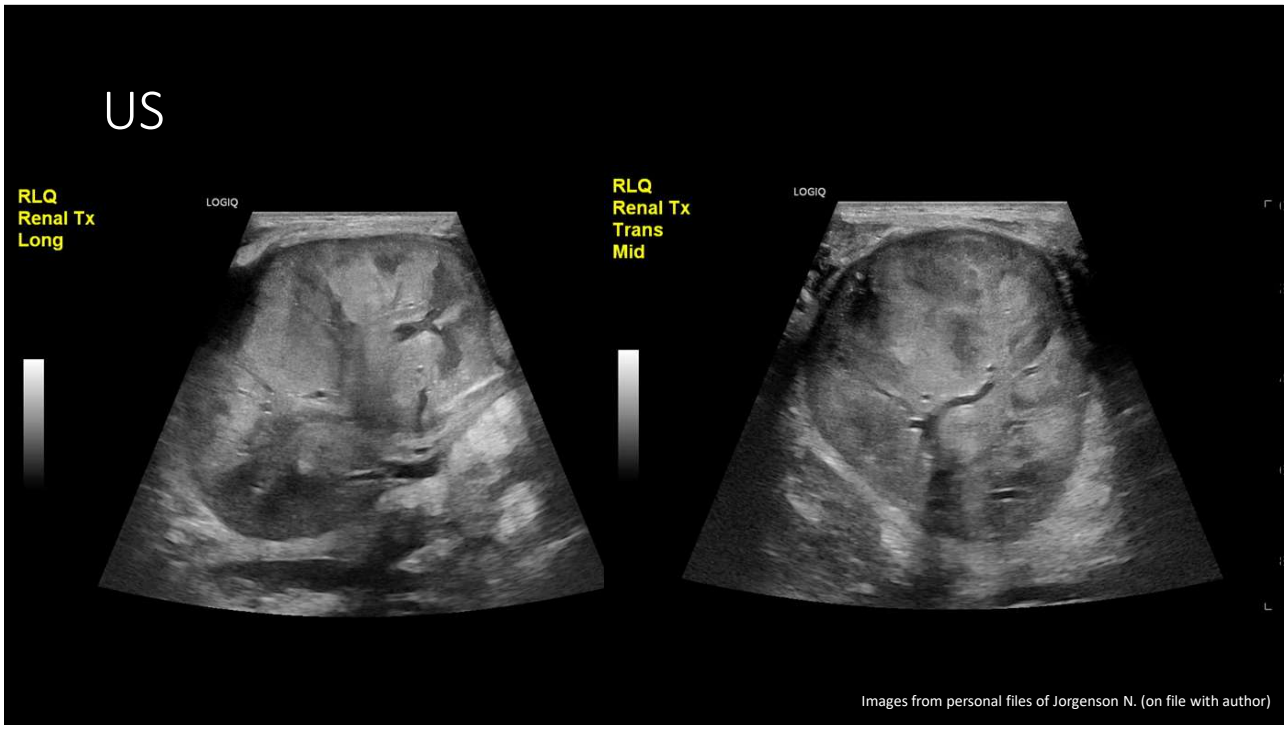
Case #5

93

Patient History

- 30-year-old presenting for a second opinion
- End stage renal disease of unknown etiology
- Kidney tx two years prior at outside institution
- Persistent and worsening acute cellular rejection
- Returned to dialysis
- Diffuse abdominal pain

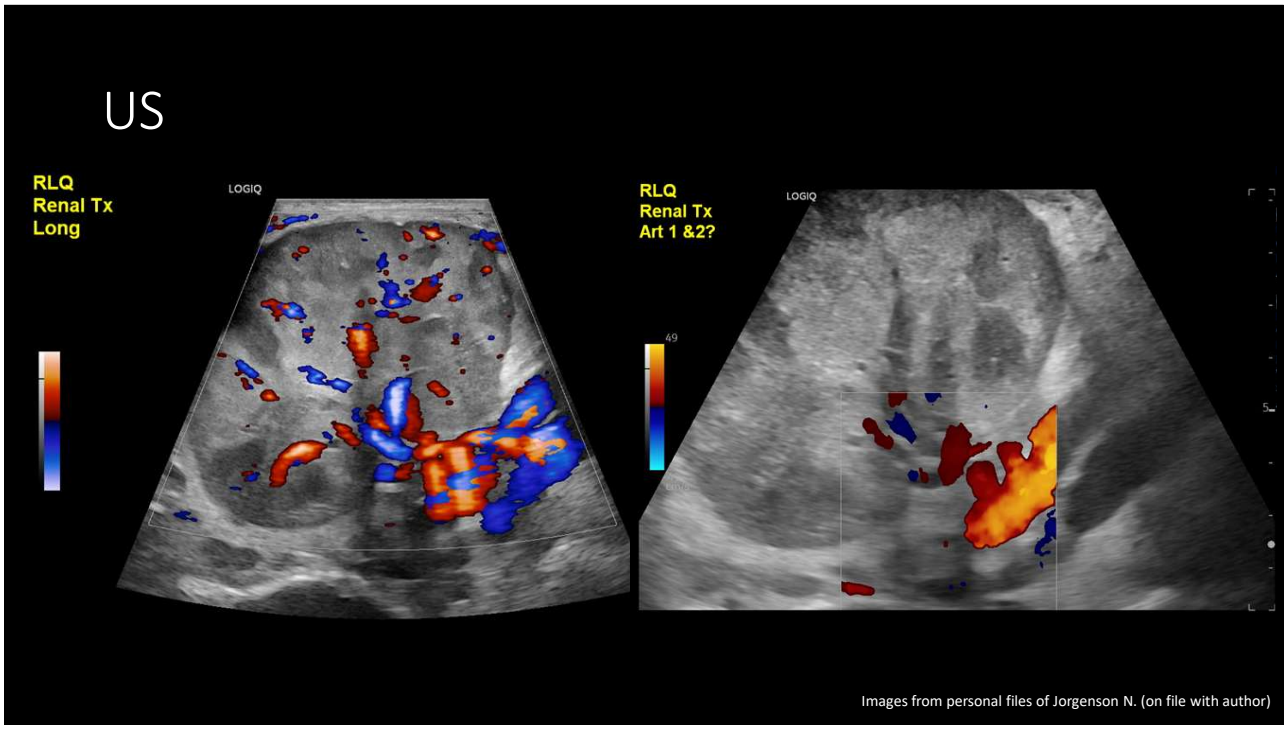
94



95

96

US



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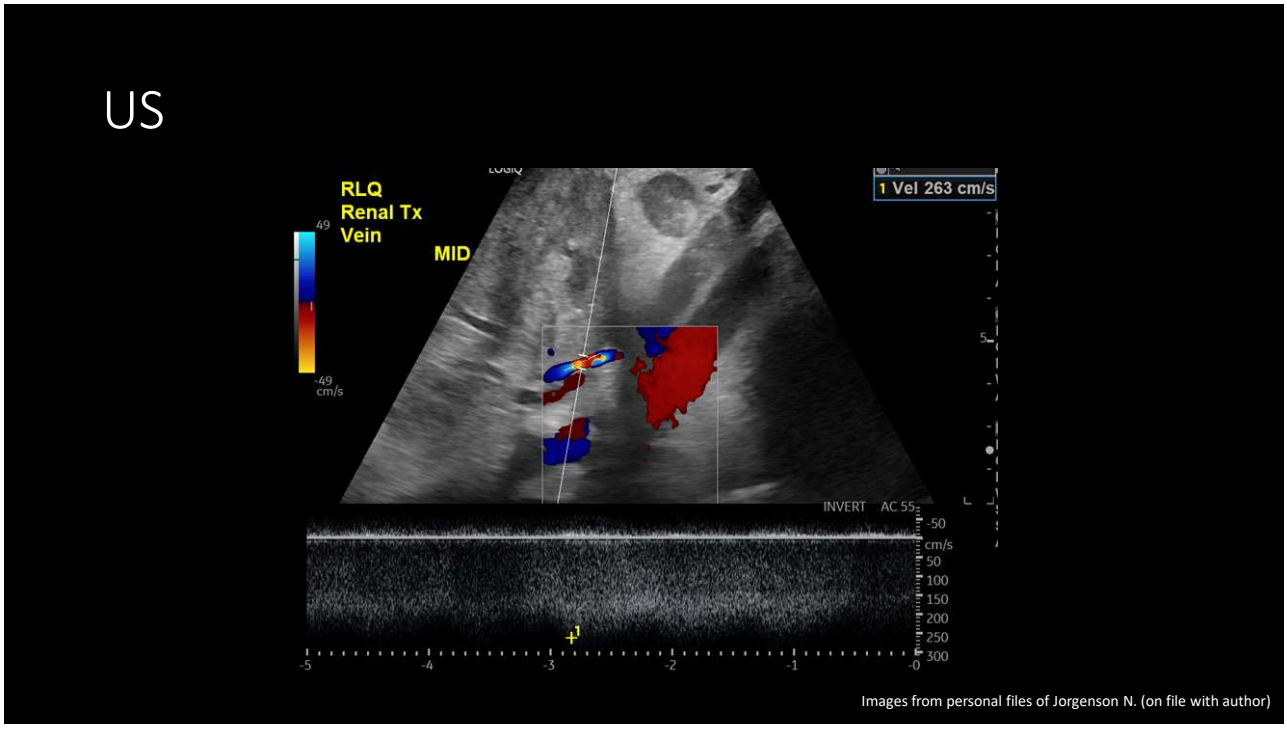
US



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98

US Report

- Markedly echogenic and edematous tx likely due to rejection
- Diminished corticomedullary differentiation
- Severe renal vein stenosis
  - Likely related to compression by the edematous kidney
- Pt will need new kidney tx

99

Case #6

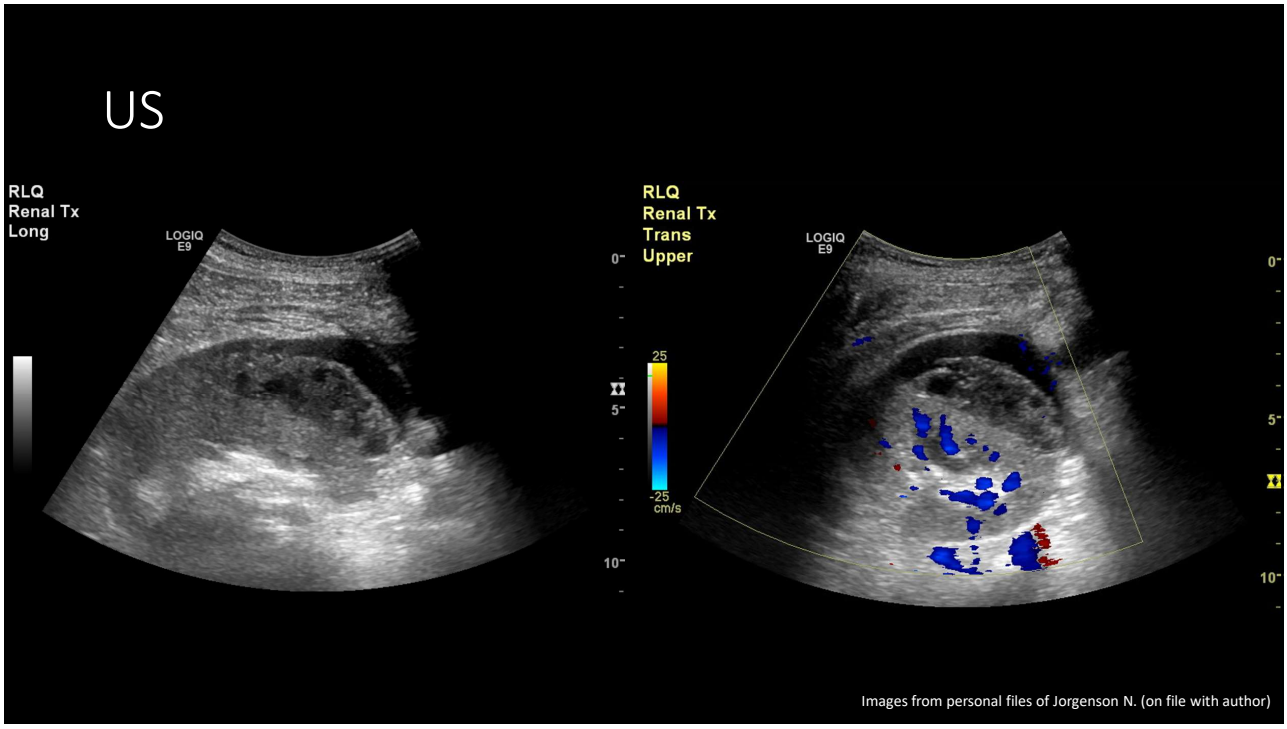
100

Patient History

- 61-year-old male
- 2 months post tx: creatinine 5.2
- Patient recently started on Plavix
- Scheduled for a renal tx scan and bx

101

US



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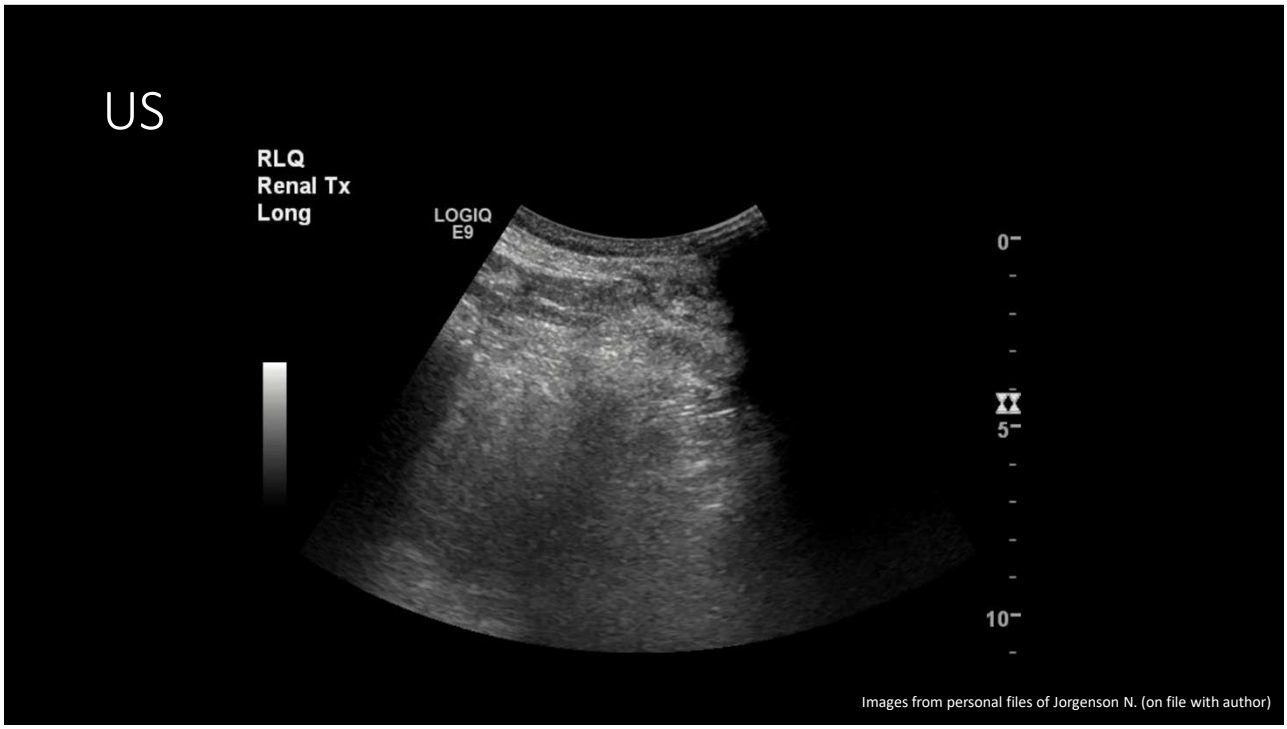

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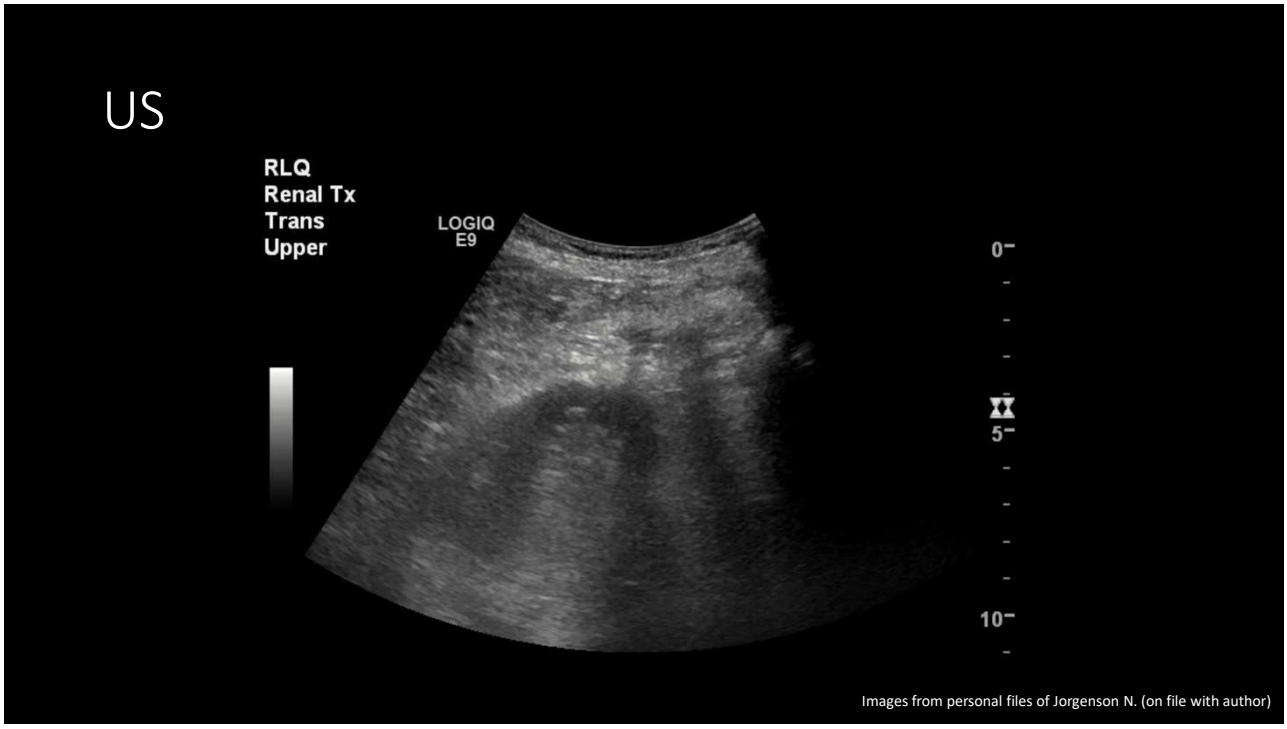
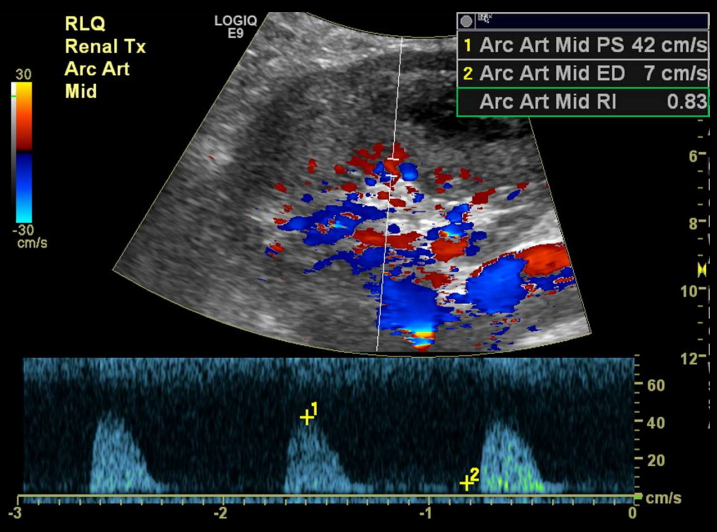


104

What do you see?

105

US



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106

Follow-up

- Biopsy was canceled
- Patient was taken to the OR to evacuate the presumed subcapsular hematoma

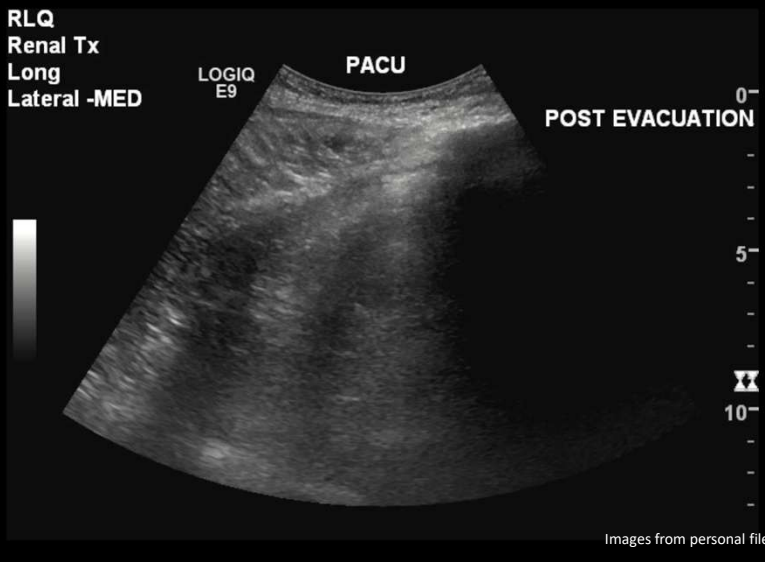
107

Follow-up

- Surgical report confirmed a subcapsular hematoma extending the entire length of the kidney tx
- Hematoma was evacuated successfully

108

US after surgery



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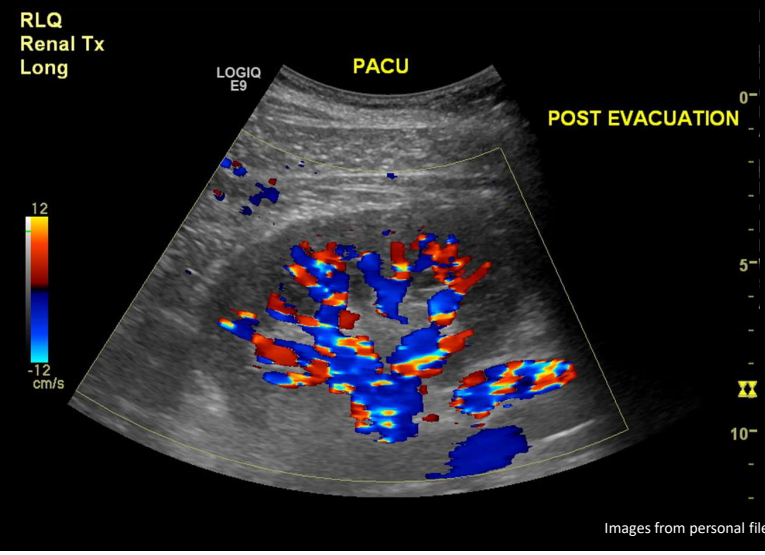
US after surgery



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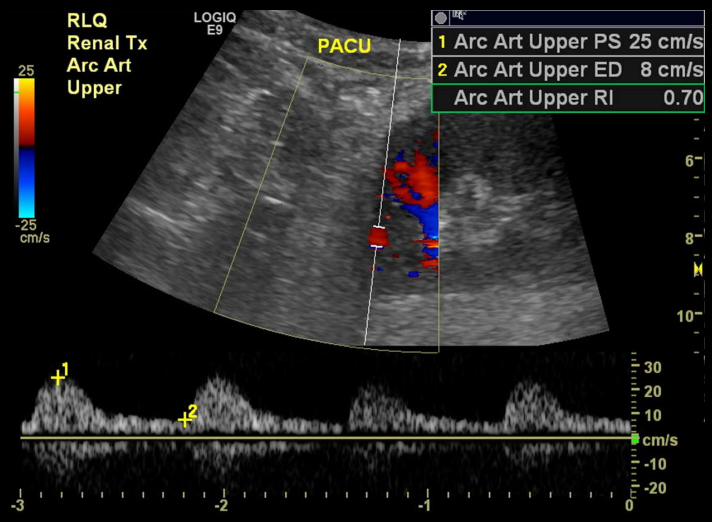
110

US after surgery



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111

Follow-up

- Improved arcuate RIs
- Creatinine decreased to 1.9 following surgery and is down to 1.7 a week later

112

References

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