Peripheral Artery and Bypass Cases

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2021

ABI + Duplex Imaging

- Baseline PVR
  - Typically no duplex unless there is hx prior intervention or concern for acute limb ischemia
  - PVR can be used as an alternative to duplex when assessing for total perfusion
- ABI + lower arterial duplex s/p intervention and surveillance
  - Increase ability to intervene much sooner and before ABI decreases
  - Increase longevity of bypasses and success of surgical intervention

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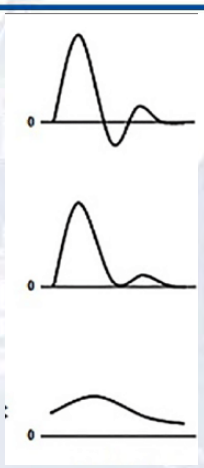
Johns Hopkins Non-Invasive Vascular Lab Criteria for ABIs

ABI	DEGREE OF ABNORMALITY	WAVEFORM PATERN
>1.4	Unable to assess; calcified	Variable
1.0-1.4	Normal	Triphasic or Biphasic
0.91-0.99	Borderline	Triphasic or Biphasic
0.70 to 0.90	Mild	Triphasic or Biphasic
0.40-0.69	Moderate	Monophasic, Quick systolic acceleration
<0.40	Severe	Monophasic, Slow systolic acceleration, Tardus et parvus



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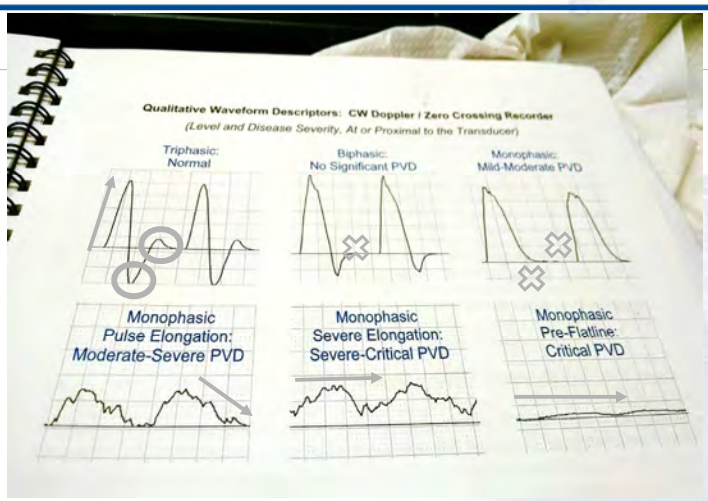
Interpreting an ABI Doppler waveform



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PVR Interpretation Criteria

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Where is the arterial disease and how severe is it?

- **Location** and **severity** of disease
- Plethysmography waveforms at the level of the thigh, calf, ankle & metatarsal
- Segmental pressures at the level of the thigh, calf & ankle (ABI included)
- **Compare pressures and waveform quality from limb to limb & segment to segment **

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What kind of disease?

- Thigh level abnormal waveform
  - Aorto-Iliac, ileofemoral, and/or common femoral, femoral artery disease (inflow)
- Calf level abnormal waveform
  - Femoral-Popliteal Artery disease (outflow)
- Ankle level abnormal waveform
  - Run-Off disease
- Abnormal waveforms at more than one level
  - Multi-segmental disease

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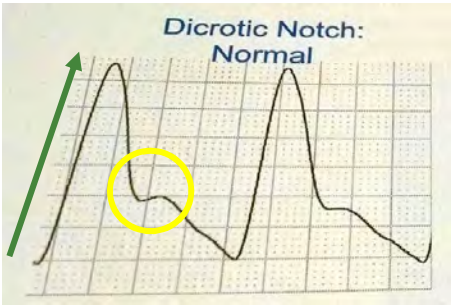
Normal PVR waveform

- Sharp systolic peak with prominent dicrotic notch



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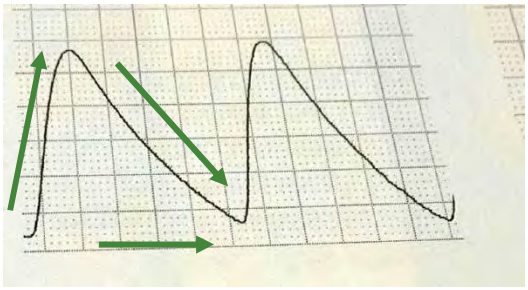
Mildly Abnormal

- Sharp peak, absent dicrotic notch and downslope is bowed away from baseline and delayed



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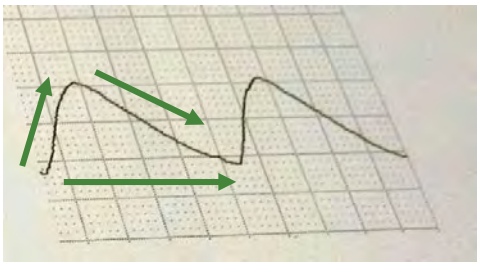
Moderately Abnormal

- Flattened systolic peak, upslope and downslope time decreased and nearly equal, and absent dicrotic notch



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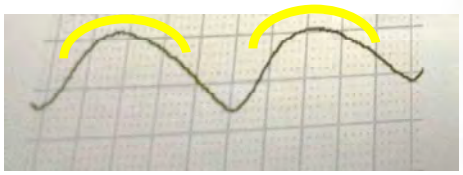
Severely Abnormal

- Absent or low amplitude pulse wave with equal upslope and downslope time



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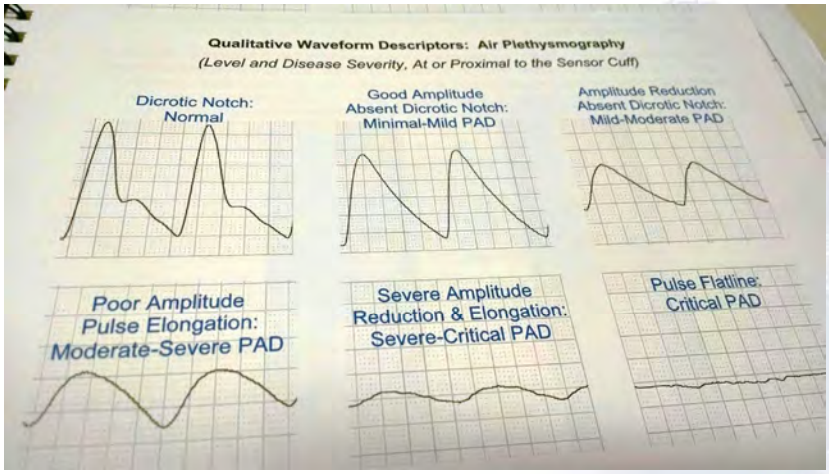
PVR Doppler waveform criteria



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What to Pay Attention to When Interpreting Duplexes

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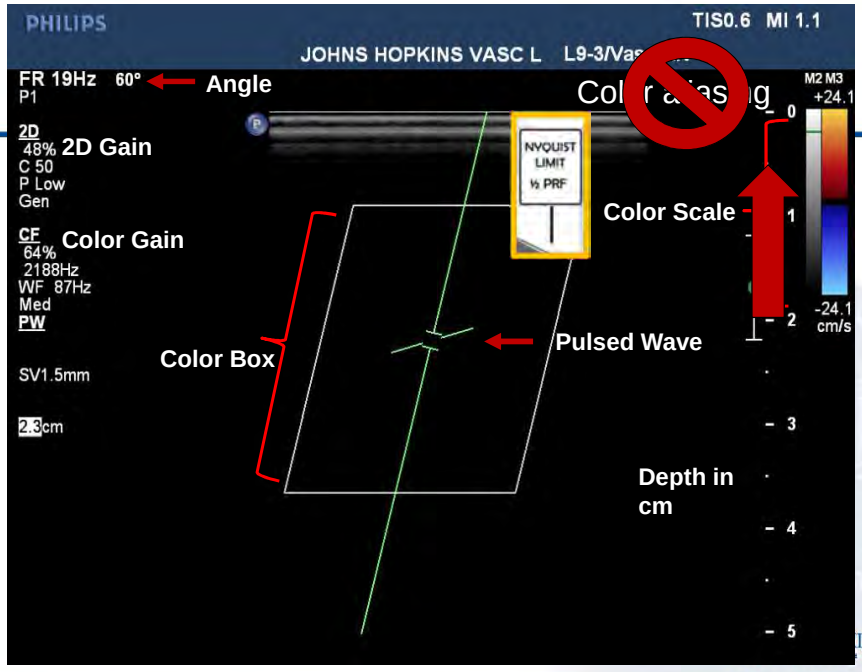
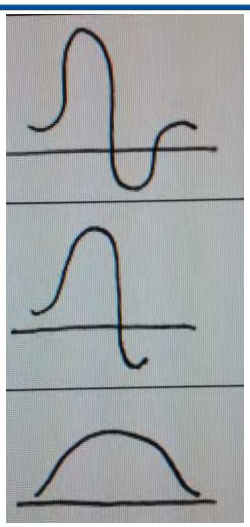
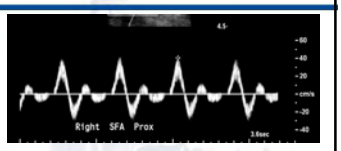


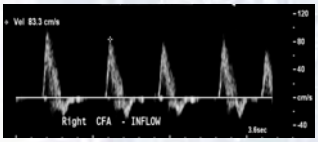
Types of Arterial Waveforms



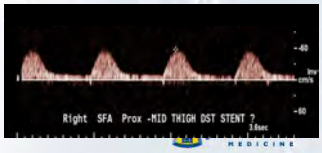
- Triphasic



- Biphasic

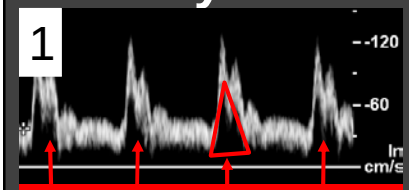


- Monophasic



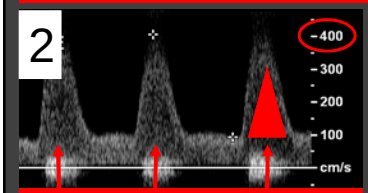
Hemodynamics:

1



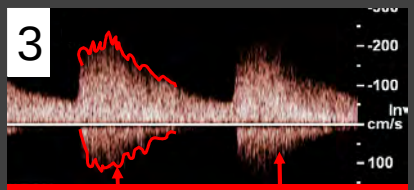
Disease free vessel: Spectral Window, indicative of laminar flow.

2



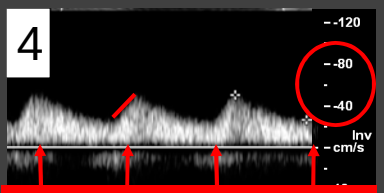
At a stenosis:
Spectral broadening & elevated velocities.

3



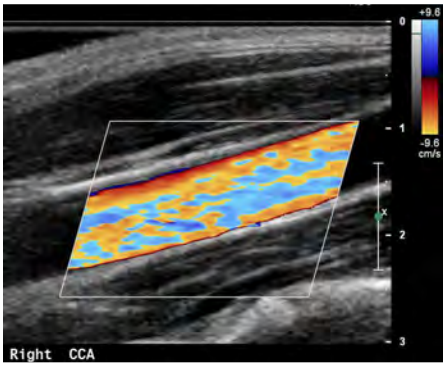
Immediately distal to a stenosis: Spectral broadening, "ratty" waveform, above & below baseline flow.

4



Distal to hemodynamically significant stenosis:
Tardus parvus (delayed upstroke).

How to determine if depicted aliasing is real:



Artifactual Aliasing:
- No vessel narrowing

Appropriate Aliasing:
- Narrowed lumen

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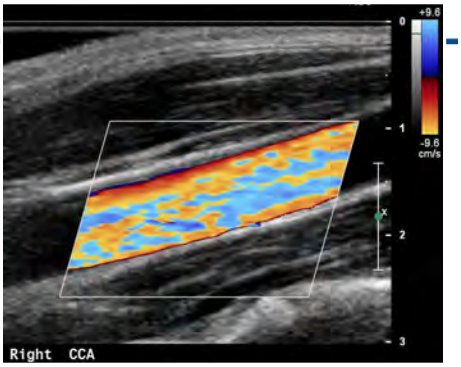
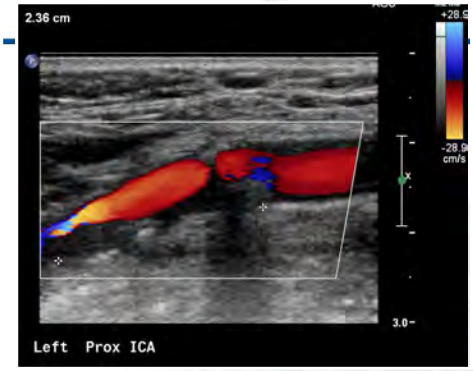
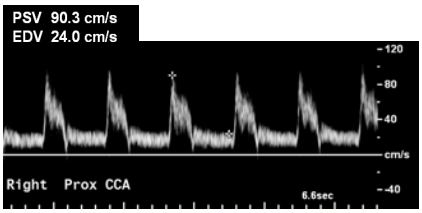
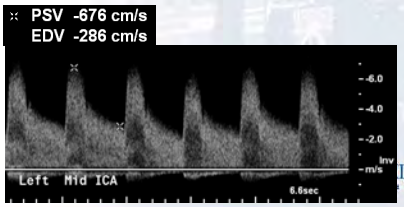
How to determine if depicted aliasing is real:



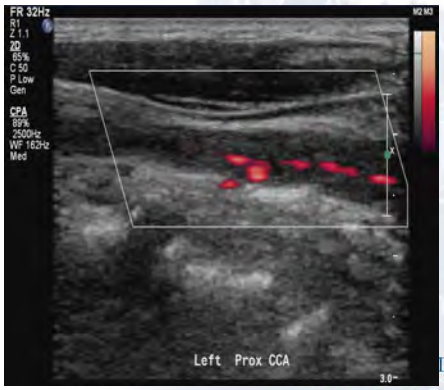






Power Doppler (CPA)

- Increased flow sensitivity; used to detect the presence of flow in vessels that are poorly imaged with conventional color Doppler



Duplex Criteria For Arteries

% Diameter Reduction	Spectral Waveform Characteristics	PSV at proximal segment
Normal	▪ Triphasic/biphasic waveform ▪ No spectral broadening ▪ Smooth walls ▪ No evidence of calcifications	
1-49% Mild Stenosis	▪ Triphasic/biphasic waveform ▪ Minimal spectral broadening ▪ Normal proximal and distal waveforms	
50-69% Moderate Stenosis	▪ Triphasic/biphasic waveform ▪ Prominent spectral broadening ▪ Area of focal narrowing identified by an abrupt disruption of the color flow image and localized PSV increase ▪ Normal proximal and distal waveform	2:1
70-89% Moderately to Severe Stenosis	▪ Monophasic waveform ▪ Extensive spectral broadening ▪ Visible narrowing of the lumen on both gray scale and color imaging ▪ Pre-occlusive “thump” ▪ Proximal waveforms monophasic with reduced PSV	3:1
90-99% Severe Stenosis	▪ Monophasic waveform ▪ Visible narrowing of the lumen on both gray scale and color imaging ▪ Pre-occlusive “thump” ▪ Proximal waveforms monophasic with reduced PSV	4:1
100% Occlusion	• Low diastolic flow proximally • Pre-occlusive “staccato” waveform • Graft filled with increased echoes • Monophasic waveform distal to the occlusion	No flow detected

In-stent Stenosis

Degree of Stenosis in %	Stenosis 50-69%	Stenosis 70-99%
Duplex Velocity PSV/EDV cm/sec	≥200-300/<45	≥300/ >45
Velocity Ratio (PSV max/PSV prox)	2.0-3.0	>3.0

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Criteria for Bypass Graft Assessment

Criteria	Doppler Waveforms	Velocity	Imaging	ABI
Normal	▪ Triphasic/biphasic	▪ PSV > 45 cm/s ▪ No focal increase in PSV noted	▪ No structural defects observed in graft or at anastomoses ▪ Normal flow velocities in arterial vessels prox/dst to graft anastomoses	▪ Improvement in ABI when compared to pre-operative ABI ▪ No change or improvement in ABI compared to previous serial F/U study
Abnormal	▪ Monophasic/ blunted waveforms ▪ Monophasic and continuous waveforms ▪ Audible but not visible ▪ Not audible	▪ PSV <40-45 cm/s ▪ Localized increase in PSV (>120 cm/s) ▪ Reduction in PSV throughout graft when compared to post-operative level	▪ Structural defects within the bypass and/or at anastomotic site ▪ Stenosis noted by flow velocities in arterial vessels proximal and/or distal to graft anastomoses	▪ Minimal increase (<0.15 to 0.20) or no improvement in ABI following surgery ▪ Reduction in ABI (>0.15 to 0.20) compared to post-surgical/ previous serial F/U ABI

Case #1

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Case #1

74 yo male presents with new onset of the left lower extremity pain after foam rolling calf and hamstrings. Incidental finding of aneurysmal left popliteal artery on venous duplex exam.

- Relevant patient history
  - AAA
  - CAD
  - MI
  - HTN
  - Carotid stenosis
- Relevant surgical history
  - Endovascular repair of AAA
  - Left carotid endarterectomy

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Case #1
Outline

- Baseline ABI + bilateral lower extremity duplex - 8/6/2018
- CTA - 8/7/2019
- Angiography + Intervention - 8/14/2018
- Follow-up ABI + bilateral lower arterial duplex - 10/1/2018

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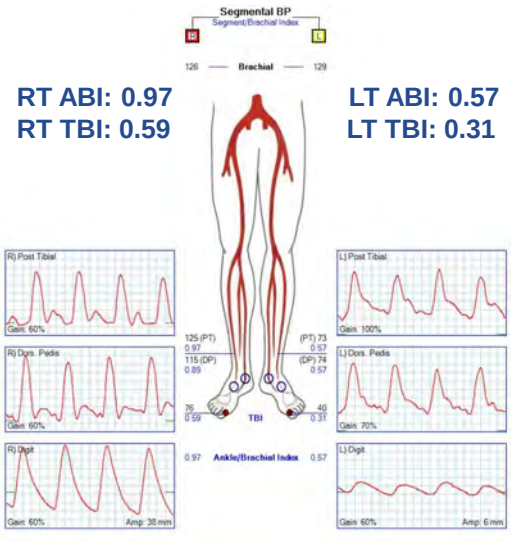
ABI
8/6/2018



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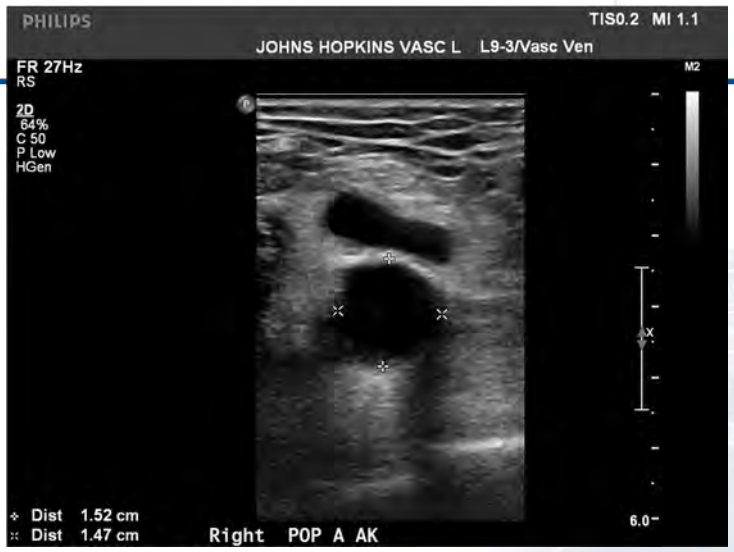
Right lower extremity arterial duplex




PHILIPS
TIS0.2 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 27Hz
RS
2D
64%
C 50
P Low
HGen
M2
6.0
Dist 1.51 cm
Right POP A AK


PHILIPS
TIS0.4 MI 0.5
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 15Hz 60°
P1
2D
54%
C 50
P Low
Gen
CF
61%
1313Hz
WF 45Hz
Med
PW
68%
WF 50Hz
SV2.0mm
M3
3.5MHz
3.1cm
M2 M3
+14.4
-14.4
cm/s
Vel 80.9 cm/s
6.0
80
40
cm/s
-40
Right POP A AK
6.6sec

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Left lower extremity arterial duplex

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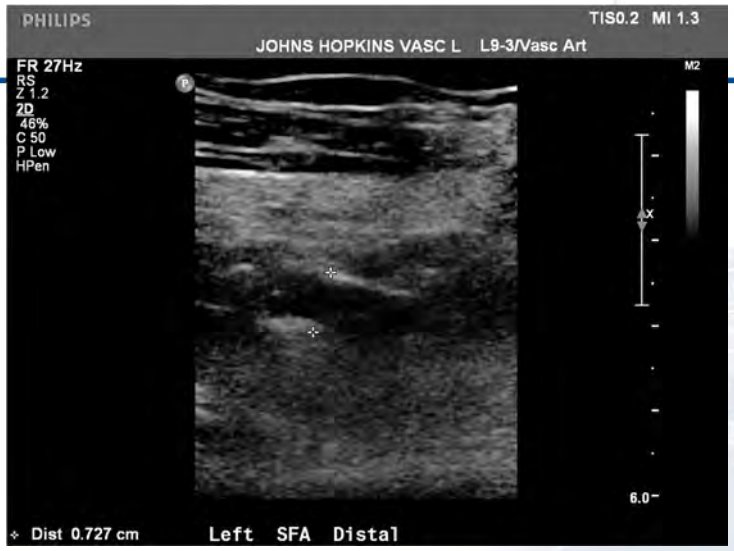

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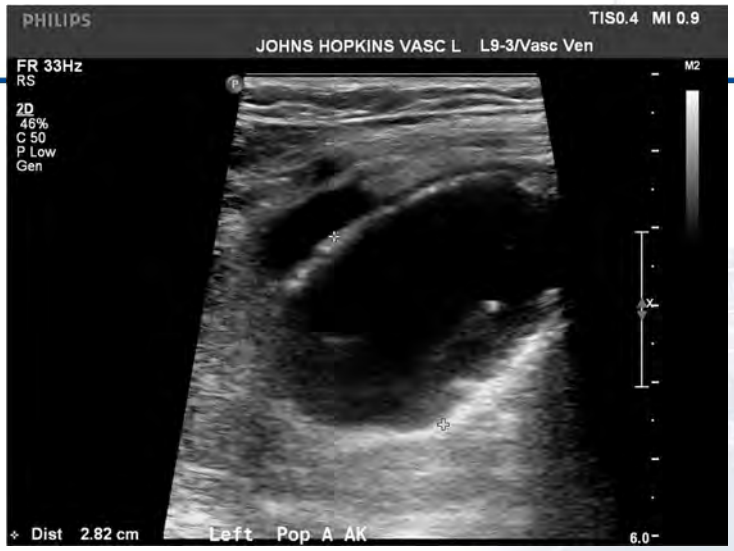
PHILIPS
TIS0.6 MI 0.9
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 10Hz
P1
2D
61%
C 50
P Low
Gen
CF
60%
656Hz
WF 29Hz
Low
M2 M3
+7.2
-7.2
cm/s
6.0
Left Pop A AK


PHILIPS
TIS0.4 MI 0.5
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 10Hz 52°
P1
2D
58%
C 50
P Low
Gen
CF
60%
656Hz
WF 29Hz
Low
PW
52%
WF 50Hz
SV2.0mm
M3
3.5MHz
3.1cm
M2 M3
+7.2
-7.2
cm/s
Vel 57.6 cm/s
6.0
80
40
cm/s
-40
Left Pop A AK
6.6sec


PHILIPS
TIS0.4 MI 0.9
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 33Hz
RS
2D
48%
C 50
P Low
Gen
M2
Left Pop A AK
6.0


PHILIPS
TIS0.4 MI 0.9
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 33Hz
RS
2D
46%
C 50
P Low
Gen
M2
Dist 2.82 cm
Left Pop A AK
6.0

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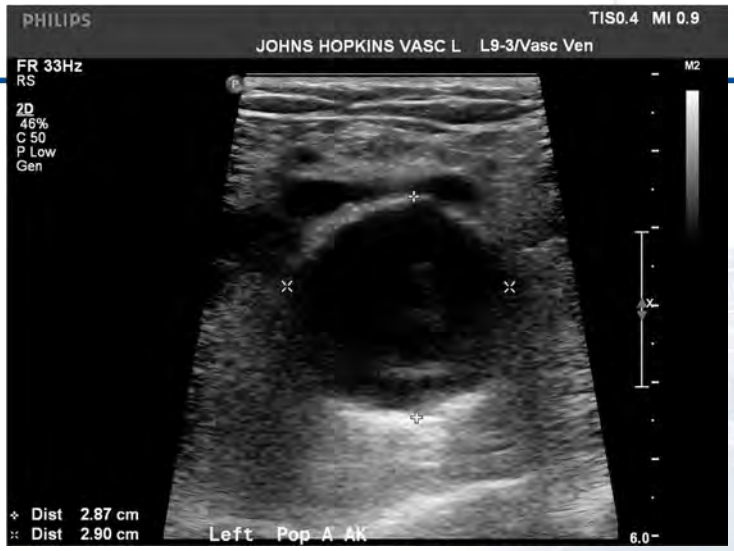
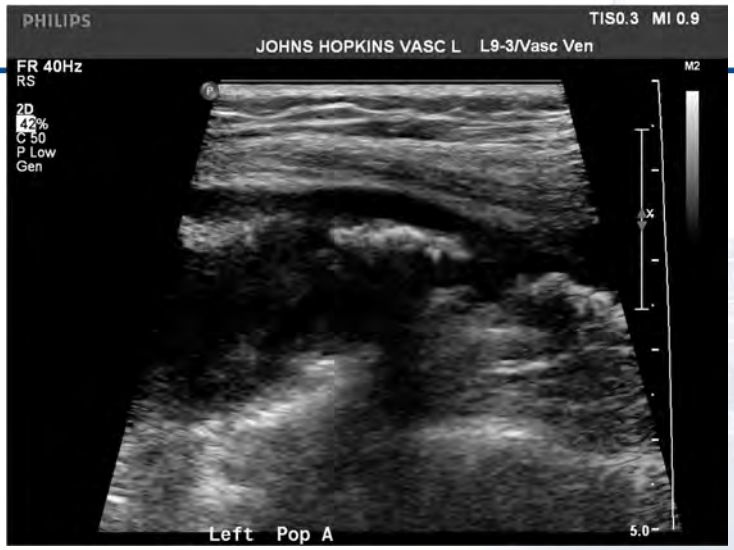
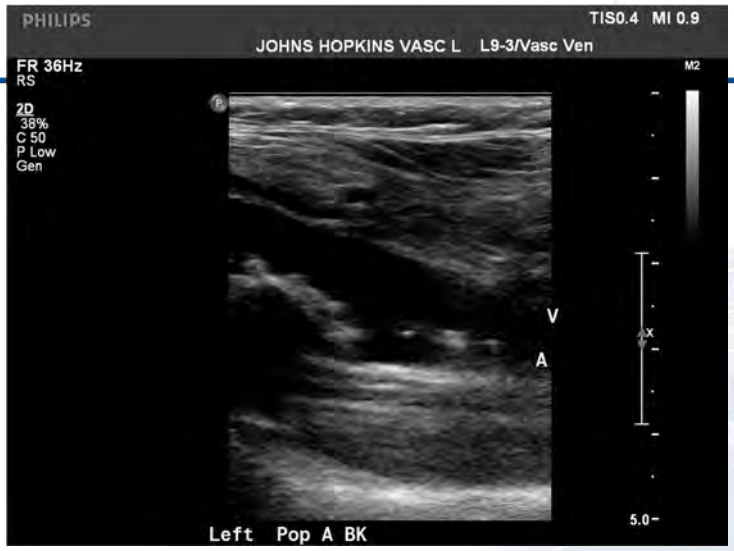


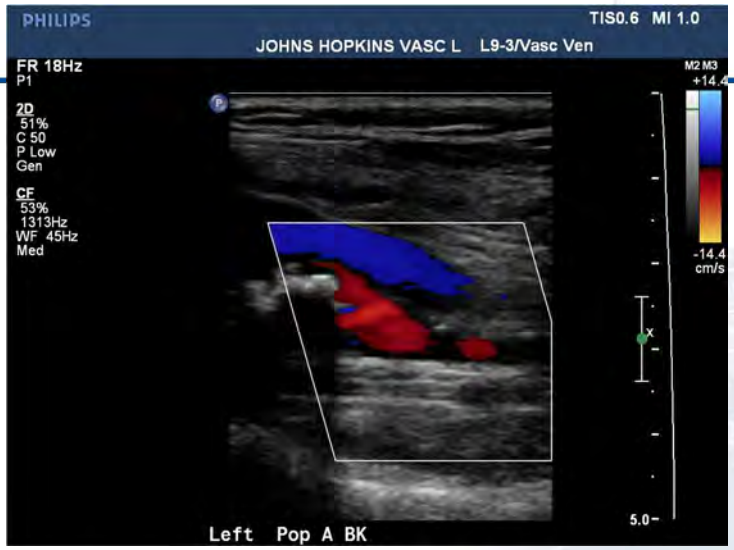
JOHNS HOPKINS MEDICINE


PHILIPS
TIS0.6 MI 1.2
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 11Hz
P1
2D
59%
C 50
P Low
Gen
CPA
69%
750Hz
WF 56Hz
Med
M2 M3
Left Pop A AK
6.0


PHILIPS
TIS0.3 MI 0.9
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 40Hz
RS
2D
42%
C 50
P Low
Gen
M2
Left Pop A
5.0


PHILIPS
TIS0.2 MI 0.9
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 18Hz 60°
P1
2D
50%
C 50
P Low
Gen
CF
53%
1313Hz
WF 45Hz
Med
PW
48%
WF 40Hz
SV2.0mm
M3
3.5MHz
3.0cm
M2 M3
+14.4
-14.4
cm/s
Vel -18.3 cm/s
5.0
-30
-20
-10
Inv
cm/s
10
20
Left Pop A BK
6.6sec


PHILIPS
TIS0.4 MI 0.9
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 36Hz
RS
2D
38%
C 50
P Low
Gen
M2
V
A
5.0
Left Pop A BK



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Bilateral lower arterial duplex 8/6/2018

- Right lower extremity arterial duplex demonstrated an ectatic popliteal artery measuring up to 1.52cm. There was abnormal flow through the popliteal and tibio-peroneal trunk.
- Left lower extremity arterial duplex demonstrated an aneurysm measuring up to 2.9 cm with mural thrombus. There was also abnormal flow in the popliteal artery and tibioperoneal trunk.

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CTA Abdomen Bilateral Runoff
8/7/2018

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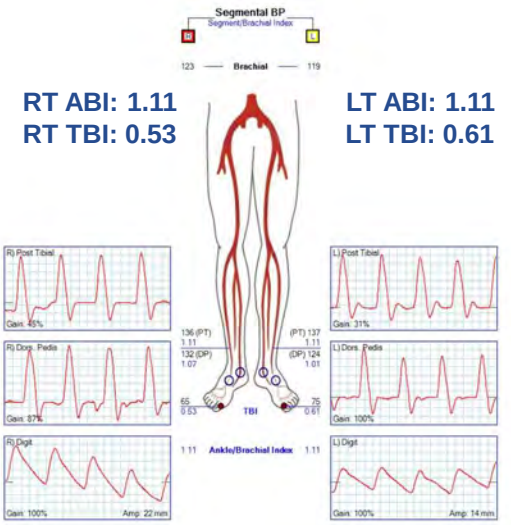
Angiography
8/14/2018

Left Leg

Right Leg

Follow-up ABI 10/1/2018

PRIOR EXAM:
RT ABI: 0.97 LT ABI: 0.57
RT TBI: 0.59 LT TBI: 0.31



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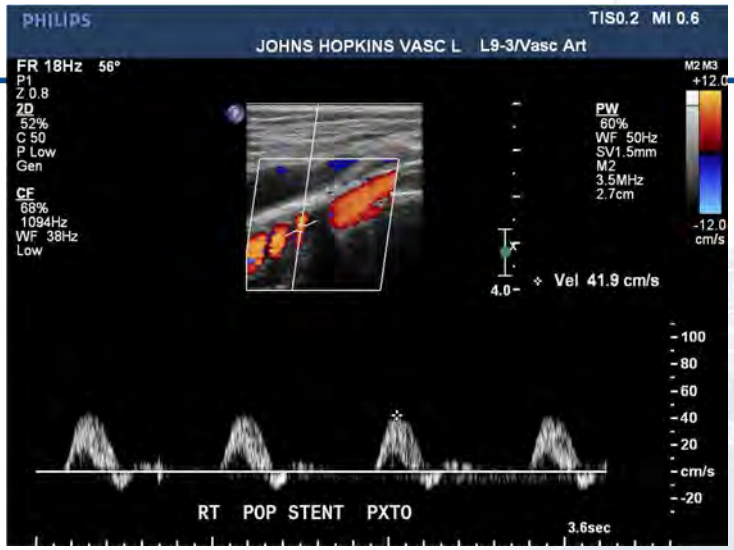
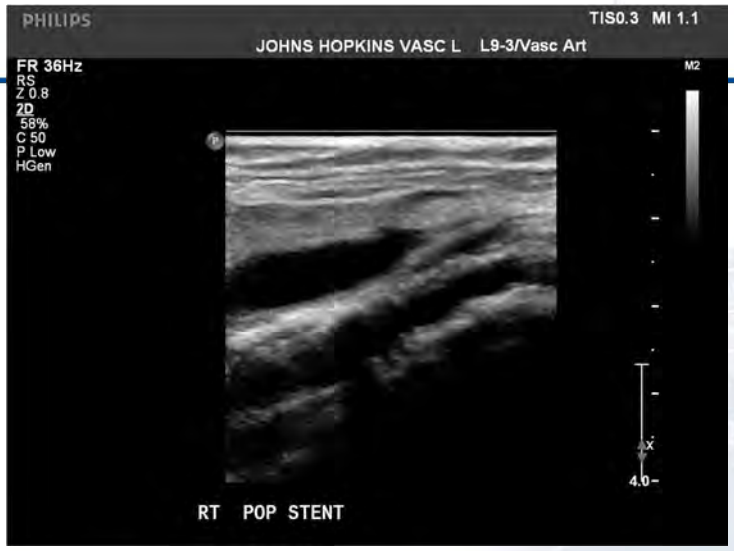
Follow-up bilateral arterial duplex 10/1/2018

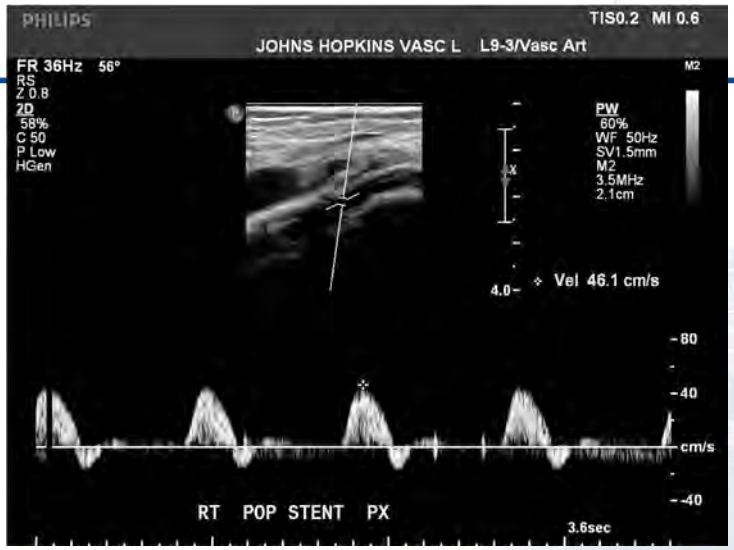
- Sonographer should perform the required protocol per their lab but should pay extra attention to the surgical intervention sites:
  - left lower extremity below-knee popliteal, tibioperoneal trunk, and pero/PTA arteries due to thrombectomy and repair of popliteal artery aneurysm with stents

JOHNS HOPKINS MEDICINE

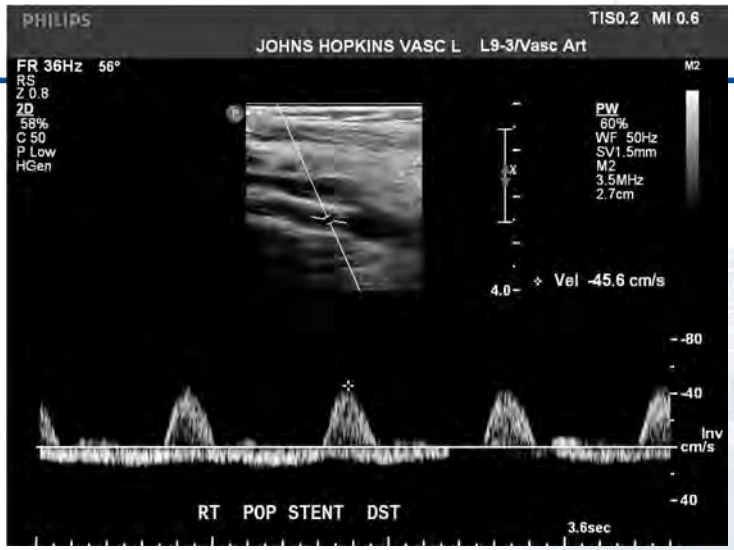
Right lower extremity arterial duplex


PHILIPS
TIS0.2 MI 0.6
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 18Hz 56°
P1
Z 0.8
2D
52%
C 50
P Low
Gen
CF
68%
1094Hz
WF 38Hz
Low
PW
60%
WF 50Hz
SV1.5mm
M2
3.5MHz
2.7cm
M2 M3
+12.0
-12.0
cm/s
4.0
Vel 41.9 cm/s
100
80
60
40
20
cm/s
-20
RT POP STENT PXT0
3.6sec

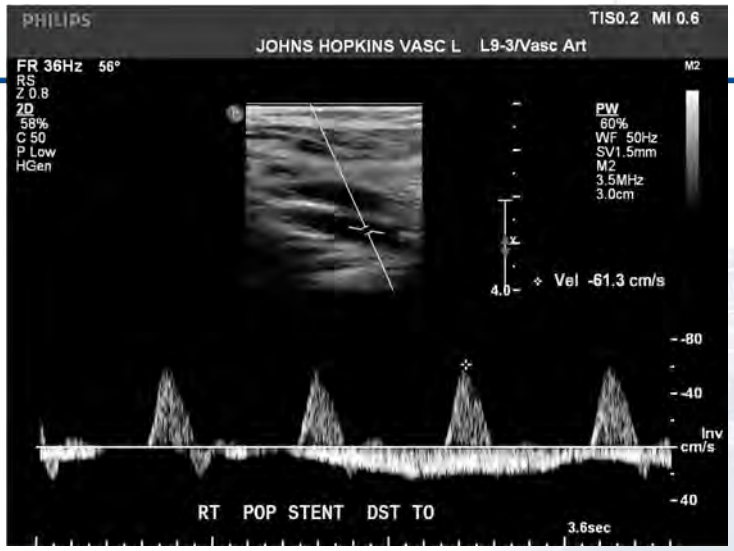

PHILIPS
TIS0.3 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 36Hz
RS
Z 0.8
2D
58%
C 50
P Low
HGen
M2
4.0
RT POP STENT


PHILIPS
TIS0.2 MI 0.6
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 36Hz 56°
RS
Z 0.8
2D
58%
C 50
P Low
HGen
PW
60%
WF 50Hz
SV1.5mm
M2
3.5MHz
2.1cm
M2
Vel 46.1 cm/s
4.0
80
40
cm/s
-40
RT POP STENT PX
3.6sec

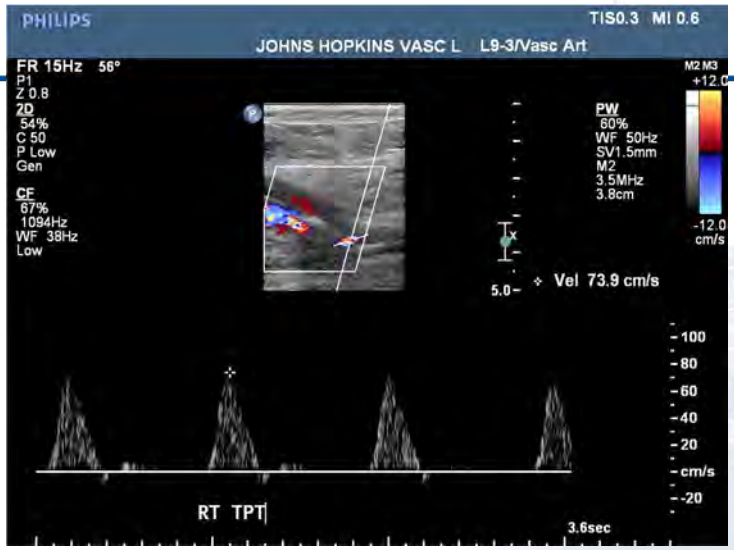

PHILIPS
TIS0.2 MI 0.6
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 25Hz 56°
P1
Z 0.8
2D
52%
C 50
P Low
Gen
CF
64%
2188Hz
WF 87Hz
Med
PW
60%
WF 50Hz
SV1.5mm
M2
3.5MHz
2.3cm
M2 M3
+24.1
-24.1
cm/s
Vel -53.5 cm/s
4.0
-80
-40
Inv
cm/s
-40
RT POP STENT MD
3.6sec



JOHNS HOPKINS MEDICINE



JOHNS HOPKINS MEDICINE



JOHNS HOPKINS MEDICINE

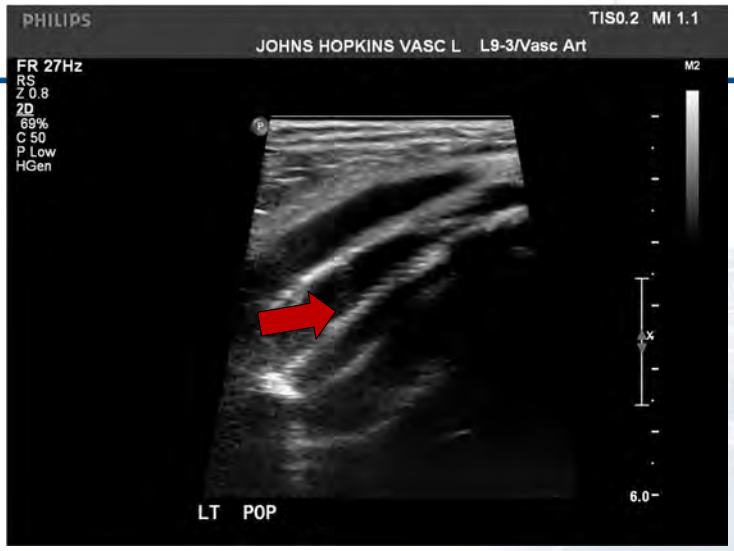
Left lower extremity arterial duplex

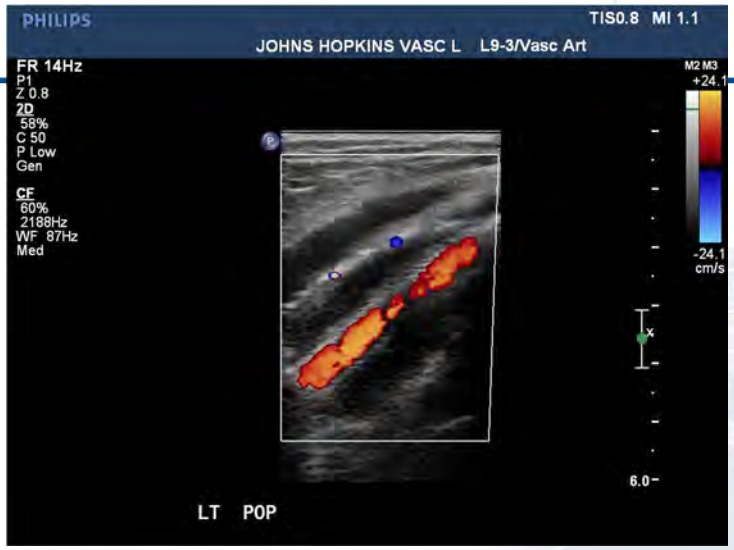
JOHNS HOPKINS MEDICINE


PHILIPS
TIS0.4 MI 0.5
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 17Hz 60°
P1
Z 0.8
2D
55%
C 50
P Low
Gen
CF
60%
2188Hz
WF 87Hz
Med
PW
60%
WF 60Hz
SV1.5mm
M2
3.5MHz
4.0cm
M2 M3
+24.1
-24.1
cm/s
6.0
Vel -80.1 cm/s
-120
-60
Inv
cm/s
-60
LT SFA DST
3.6sec

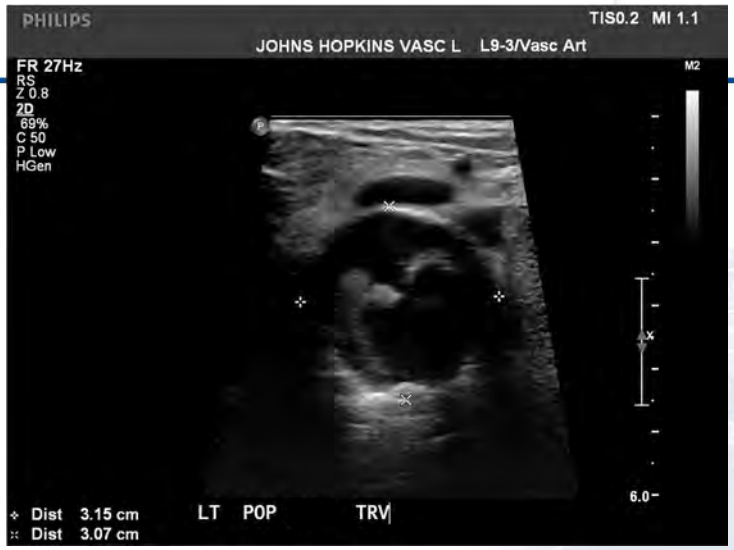

PHILIPS
TIS0.3 MI 1.1
L9-3/Vasc Art
FR 31Hz
RS
Z 0.8
2D
65%
C 50
P Low
HGen
M2
5.0
JPEG
*** bpm
LT POP FOSA

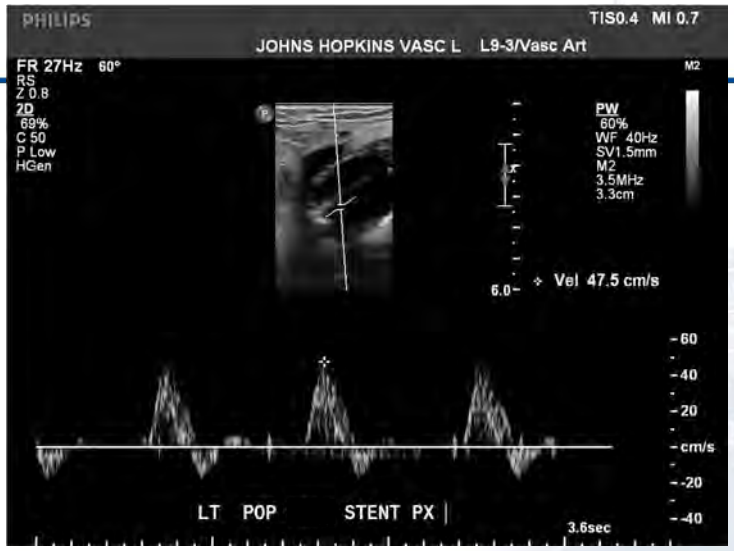

PHILIPS
TIS0.8 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 14Hz
P1
Z 0.8
2D
58%
C 50
P Low
Gen
CE
60%
2188Hz
WF 87Hz
Med
M2 M3
+24.1
-24.1
cm/s
6.0
LT POP

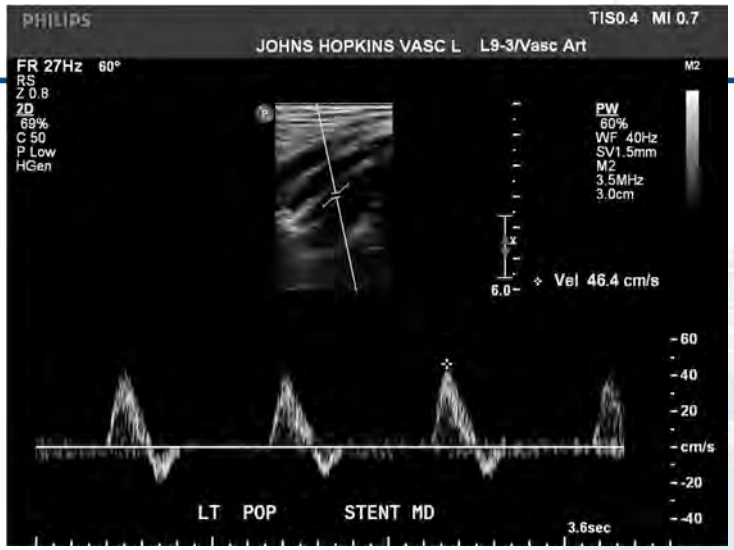

PHILIPS
TIS0.2 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 27Hz
RS
Z 0.8
2D
69%
C 50
P Low
HGen
M2
6.0
LT POP

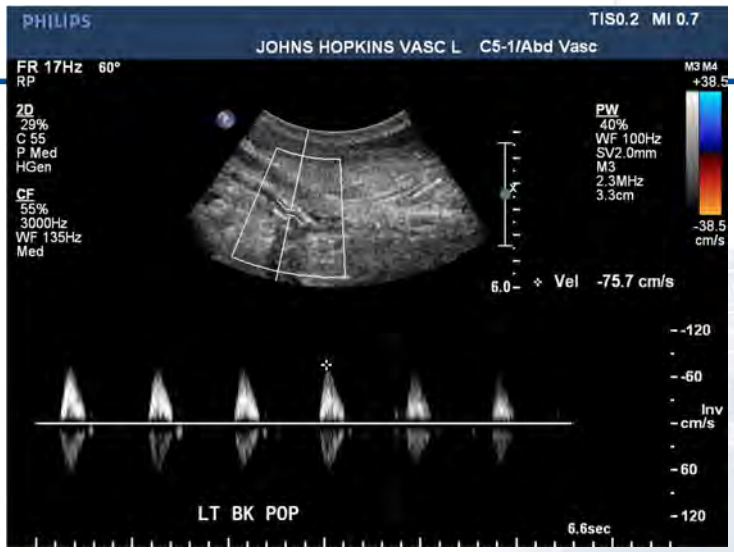

PHILIPS
TIS0.8 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 14Hz
P1
Z 0.8
2D
58%
C 50
P Low
Gen
CF
60%
2188Hz
WF 87Hz
Med
M2 M3
+24.1
-24.1
cm/s
6.0
LT POP


PHILIPS
TIS0.7 MI 1.2
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 14Hz
P1
Z 0.8
2D
58%
C 50
P Low
Gen
CF
61%
2188Hz
WF 87Hz
Med
M2 M3
+24.1
-24.1
cm/s
6.0
LT POP BK


PHILIPS
TIS0.2 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 27Hz
RS
Z 0.8
2D
69%
C 50
P Low
HGen
M2
6.0
Dist 3.15 cm
Dist 3.07 cm
LT POP TRV


PHILIPS
TIS0.4 MI 0.7
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 27Hz 60°
RS
Z 0.8
2D
69%
C 50
P Low
HGen
M2
PW
60%
WF 40Hz
SV1.5mm
M2
3.5MHz
3.3cm
6.0
Vel 47.5 cm/s
60
40
20
cm/s
-20
-40
LT POP STENT PX
3.6sec


PHILIPS
TIS0.4 MI 0.7
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 27Hz 60°
RS
Z 0.8
2D
69%
C 50
P Low
HGen
M2
PW
60%
WF 40Hz
SV1.5mm
M2
3.5MHz
3.0cm
6.0
Vel 46.4 cm/s
60
40
20
cm/s
-20
-40
LT POP STENT MD
3.6sec


PHILIPS
TIS0.2 MI 0.7
JOHNS HOPKINS VASC L C5-1/Abd Vasc
FR 17Hz 60°
RP
2D
29%
C 55
P Med
HGen
CF
55%
3000Hz
WF 135Hz
Med
M3 M4
+38.5
PW
40%
WF 100Hz
SV2.0mm
M3
2.3MHz
3.3cm
-38.5
cm/s
6.0
Vel -75.7 cm/s
-120
-60
Inv
cm/s
60
120
LT BK POP
6.6sec


PHILIPS
TIS0.2 MI 0.7
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 19Hz 60°
P1
Z 0.8
2D
54%
C 50
P Low
Gen
CF
60%
2188Hz
WF 87Hz
Med
PW
60%
WF 40Hz
SV1.5mm
M2
3.5MHz
2.5cm
M2 M3
+24.1
-24.1
cm/s
4.5
Vel -55.4 cm/s
-60
-40
-20
Inv
cm/s
20
40
LT POP BK
3.6sec


PHILIPS
TIS0.4 MI 0.7
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 18Hz 60°
P1
Z 0.8
2D
54%
C 50
P Low
Gen
CF
60%
1094Hz
WF 38Hz
Low
PW
60%
WF 40Hz
SV1.5mm
M2
3.5MHz
3.5cm
M2 M3
+12.0
-12.0
cm/s
4.5
Vel -60.1 cm/s
-60
-40
-20
Inv
cm/s
20
40
LT TPT
3.6sec


PHILIPS
TIS0.4 MI 0.7
JOHNS HOPKINS VASC L L9-3/Vasc Ven
FR 15Hz 60°
R1
2D
50%
C 50
P Low
Gen
CF
64%
1500Hz
WF 52Hz
Med
PW
44%
WF 40Hz
SV2.0mm
M3
3.5MHz
3.3cm
M2 M3
+14.4
-14.4
cm/s
Vel 37.3 cm/s
7.0
60
40
20
cm/s
-20
-40
LT PER A MD
6.6sec


PHILIPS
TIS0.2 MI 0.8
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 32Hz 60°
P1
Z 0.8
2D
51%
C 50
P Low
Gen
CF
63%
1094Hz
WF 38Hz
Low
PW
60%
WF 40Hz
SV1.5mm
M2
3.5MHz
1.2cm
M2 M3
+12.0
-12.0
cm/s
Vel 68.0 cm/s
3.0
80
60
40
20
cm/s
-20
LT PTA DST
3.6sec

Follow-up bilateral arterial duplex 10/1/2018

- Arterial duplex demonstrated patent bilateral popliteal stents with normal flow velocities. The left popliteal aneurysm sac which is now excluded is 3.15cm.
- There was slightly elevated flow velocities in bilateral proximal superficial femoral arteries. The rest of the visualized arteries are otherwise unremarkable.
- When compared to prior exam on August 6, 2018, there has been improvement in flow velocities bilaterally.

JOHNS HOPKINS MEDICINE

Case #2

JOHNS HOPKINS MEDICINE

Case #2

31 yo male presents to the ED s/p suffering a fall at a trampoline park with a left knee dislocation.

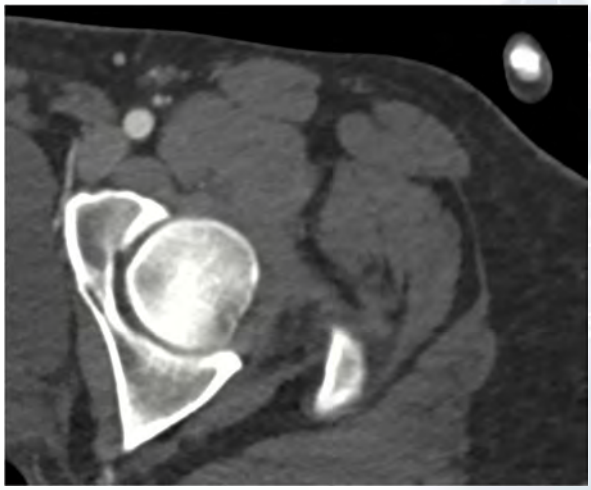
- Left dorsal pedal signals could not be obtained and posterior tibial signals were weak.

- Relevant patient history
  N/A
- Relevant surgical history
  N/A

Case #2
Outline

- Initial CTA - 1/8/2020
- Intervention - 1/8/2020
- ABI + left lower extremity arterial duplex (outpatient) - 2/17/2020
- ABI + left lower extremity arterial duplex (outpatient) – 2/22/2021

CTA Lower Extremity Left
1/8/2020



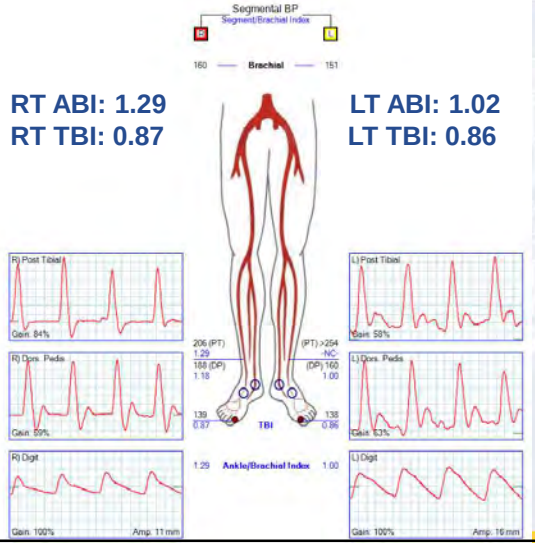
JOHNS HOPKINS MEDICINE

Case #2
Intervention
1/8/2020

- Left femoral-popliteal bypass with 8mm Propaten graft.
- Ligation of left popliteal artery injury.
- Four compartment fasciotomy of left lower leg.

JOHNS HOPKINS MEDICINE

Case #2
Follow-up ABI (outpatient)
2/17/2020



JOHNS HOPKINS MEDICINE

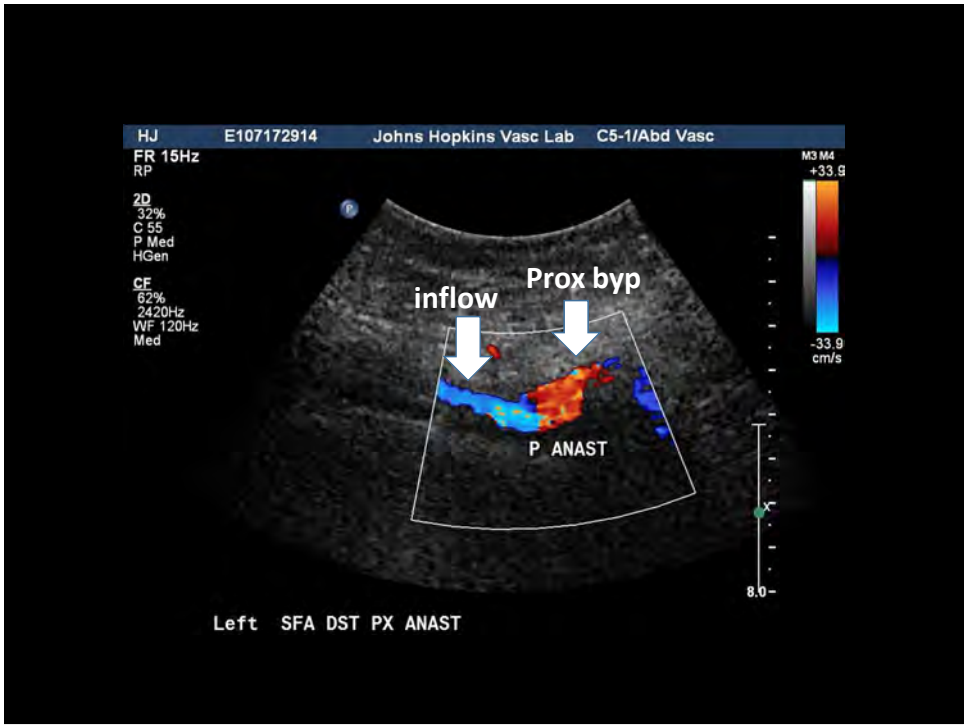
Case #2
Follow-up Bilateral Lower Extremity Arterial Duplex
2/17/2020

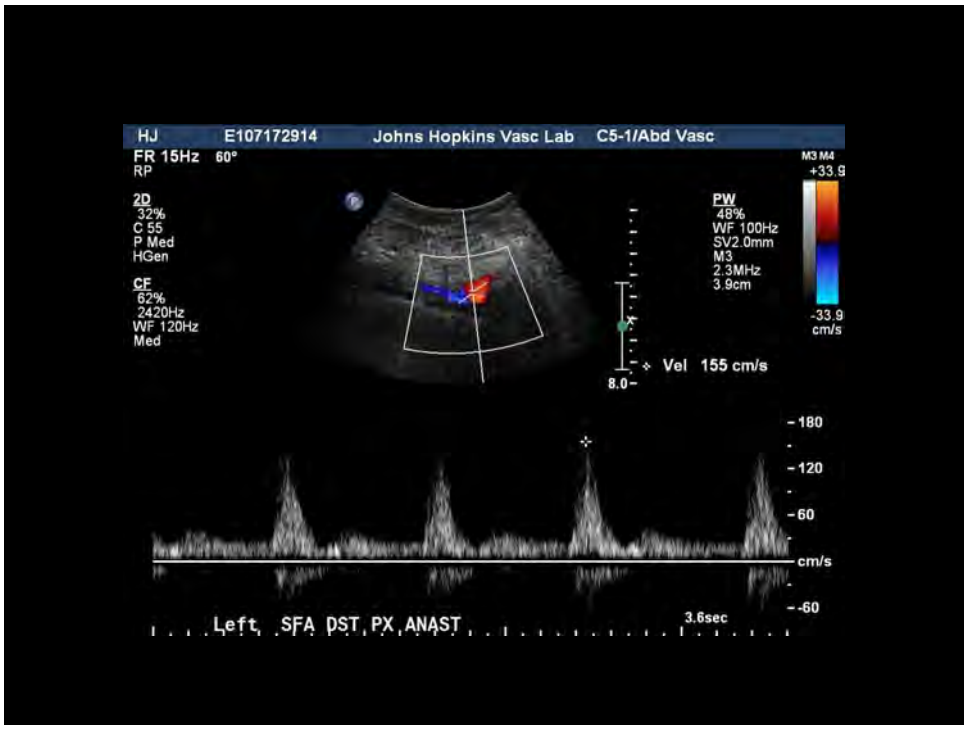
- Sonographer should perform the required protocol per their lab but should pay extra attention to the surgical intervention sites:
  - Left femoral-popliteal bypass graft.
  - Popliteal fossa for a collection due to ligation of left popliteal artery injury and prior hemorrhage

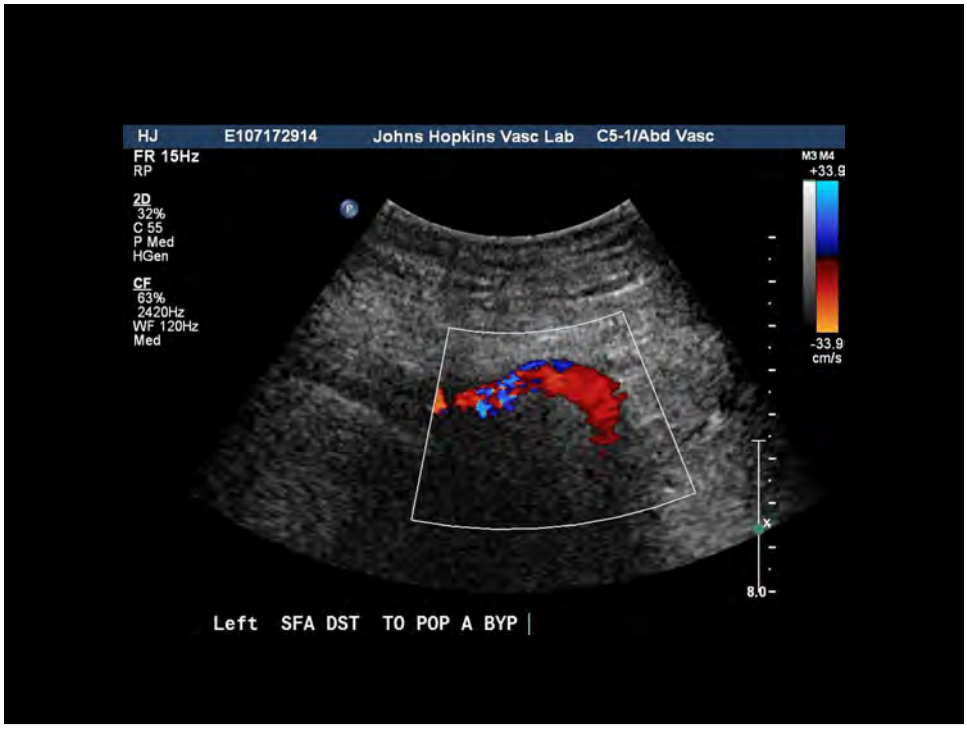
JOHNS HOPKINS MEDICINE


HJ E107172914 Johns Hopkins Vasc Lab L9-3/Vasc Ven
FR 20Hz 60°
R1
2D
53%
C 50
P Low
Gen
CF
64%
3000Hz
WF 105Hz
Med
PW
52%
WF 60Hz
SV2.0mm
M3
3.5MHz
2.3cm
M2 M3
+28.9
-28.9
cm/s
Vel 172 cm/s
4.0
180
120
60
cm/s
-60
Left CFA
3.6sec

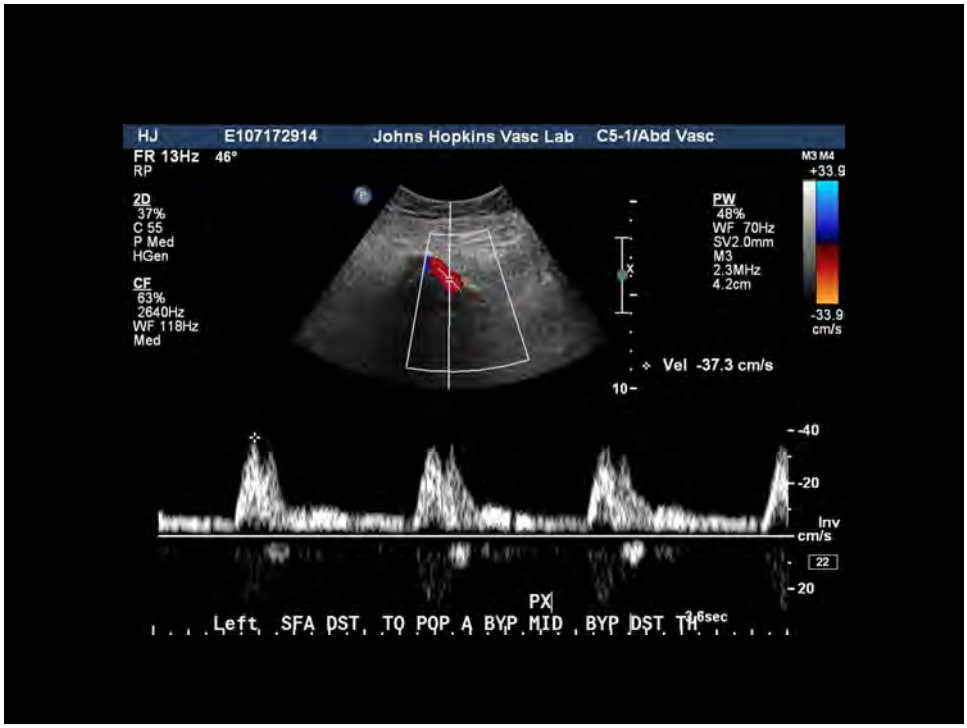

HJ E107172914 Johns Hopkins Vasc Lab L9-3/Vasc Art
FR 16Hz 60°
P1
2D
54%
C 50
P Low
Gen
CF
67%
3938Hz
WF 177Hz
Med
PW
68%
WF 60Hz
SV1.5mm
M2
3.5MHz
3.8cm
M2 M3
+43.3
-43.3
cm/s
Vel -127 cm/s
6.0
-240
-160
-80
Inv
cm/s
Left SFA Distal
3.6sec

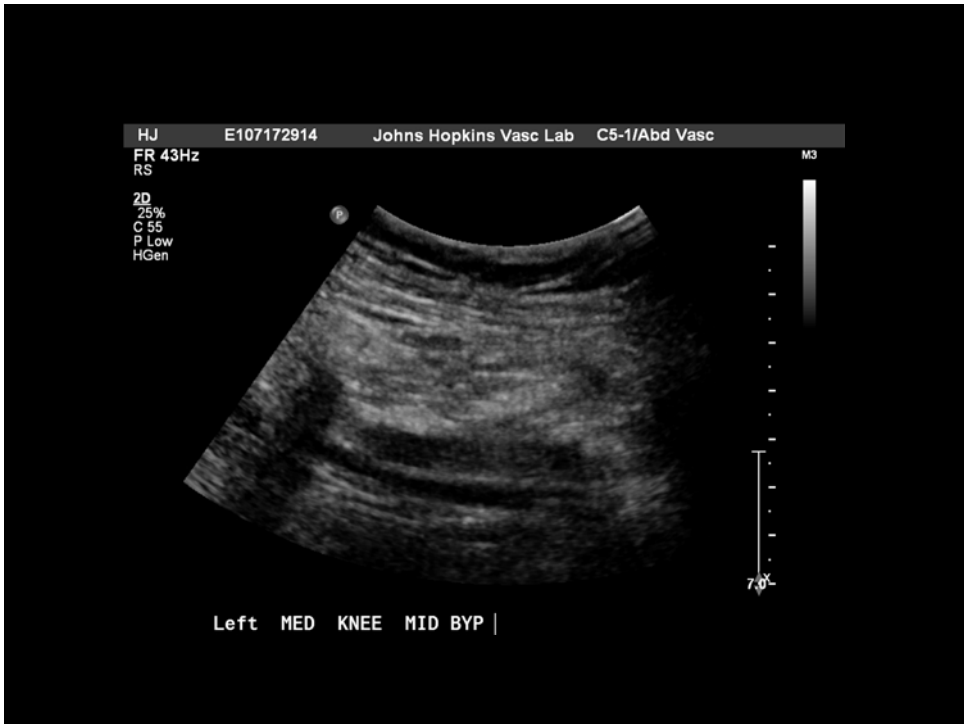

HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 15Hz
RP
2D
32%
C 55
P Med
HGen
CF
62%
2420Hz
WF 120Hz
Med
M3 M4
+33.9
-33.9
cm/s
inflow
Prox byp
P ANAST
8.0
Left SFA DST PX ANAST

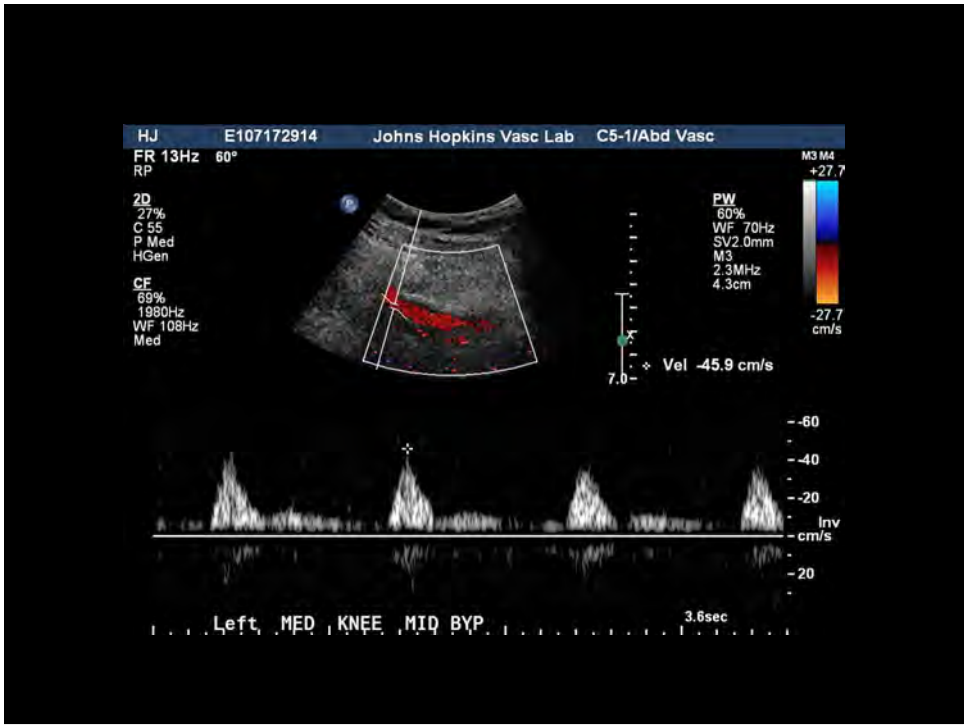

HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 15Hz 60°
RP
2D
32%
C 55
P Med
HGen
CF
62%
2420Hz
WF 120Hz
Med
PW
48%
WF 100Hz
SV2.0mm
M3
2.3MHz
3.9cm
M3 M4
+33.9
-33.9
cm/s
Vel 155 cm/s
8.0
180
120
60
cm/s
-60
Left SFA DST PX ANAST
3.6sec


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 15Hz
RP
2D
32%
C 55
P Med
HGen
CF
63%
2420Hz
WF 120Hz
Med
M3 M4
+33.9
-33.9
cm/s
8.0
Left SFA DST TO POP A BYP


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 16Hz 60°
RP
2D
32%
C 55
P Med
HGen
CF
63%
2640Hz
WF 118Hz
Med
PW
48%
WF 100Hz
SV2.0mm
M3
2.3MHz
3.2cm
M3 M4
+33.9
-33.9
cm/s
Vel 130 cm/s
8.0
120
60
cm/s
-60
Left SFA DST TO POP A BYP PX BYP DST TH
2.6sec

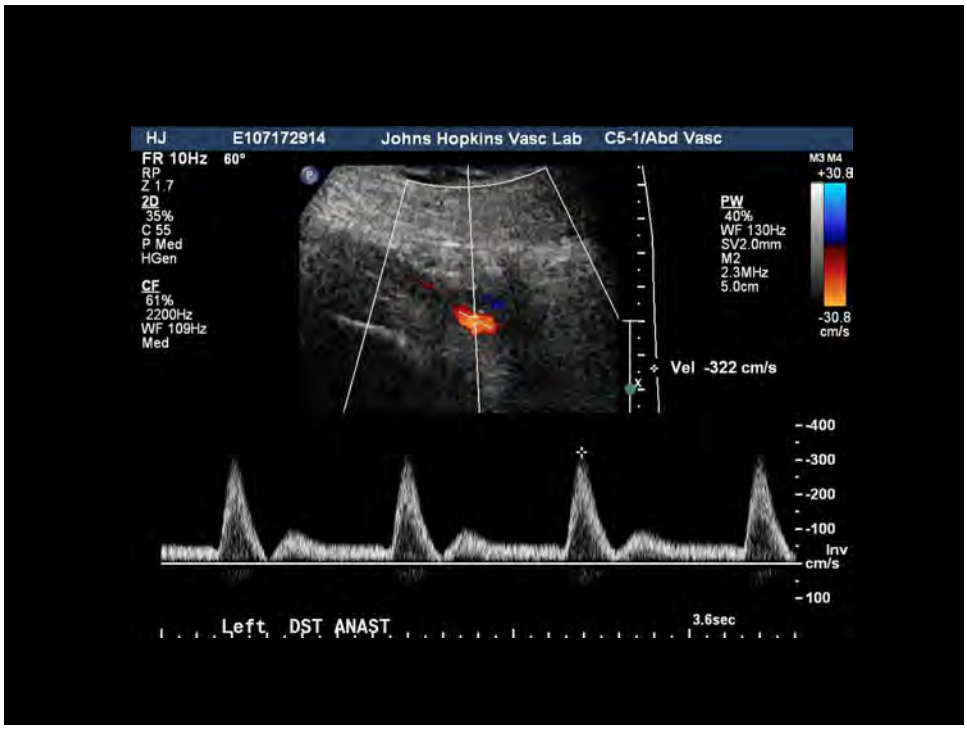

HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 13Hz 46°
RP
2D
37%
C 55
P Med
HGen
CF
63%
2640Hz
WF 118Hz
Med
PW
48%
WF 70Hz
SV2.0mm
M3
2.3MHz
4.2cm
M3 M4
+33.9
-33.9
cm/s
Vel -37.3 cm/s
10
-40
-20
Inv
cm/s
22
-20
PX
1.6sec
Left SFA DST TO POP A BYP MID BYP DST TH


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 43Hz
RS
2D
25%
C 55
P Low
HGen
M3
7.0
Left MED KNEE MID BYP


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 13Hz 60°
RP
2D
27%
C 55
P Med
HGen
CF
69%
1980Hz
WF 108Hz
Med
PW
60%
WF 70Hz
SV2.0mm
M3
2.3MHz
4.3cm
M3 M4
+27.7
-27.7
cm/s
Vel -45.9 cm/s
7.0
-60
-40
-20
Inv
cm/s
20
Left MED KNEE MID BYP
3.6sec


HJ E107172914 Johns Hopkins Vasc Lab L9-3/Vasc Art
FR 14Hz 60°
P1
2D
68%
C 50
P Low
HGen
CF
68%
1750Hz
WF 78Hz
Med
PW
64%
WF 40Hz
SV1.5mm
M2
3.5MHz
4.4cm
M2 M3
+19.3
-19.3
cm/s
Vel -33.6 cm/s
7.0
-40
-30
-20
-10
Inv
cm/s
10
Left MED KNEE MID DST BYP
3.6sec


HJ E107172914 Johns Hopkins Vasc Lab L9-3/Vasc Art
FR 15Hz 60°
P1
2D
57%
C 50
P Low
Gen
CF
64%
2188Hz
WF 87Hz
Med
PW
56%
WF 40Hz
SV1.5mm
M2
3.5MHz
3.8cm
M2 M3
+24.1
-24.1
cm/s
Vel -37.7 cm/s
7.0
-40
-30
-20
-10
Inv
cm/s
Left MED KNEE DST BYP
3.6sec


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 10Hz 60°
RP
Z 1.7
2D
35%
C 55
P Med
HGen
CF
61%
2200Hz
WF 109Hz
Med
PW
40%
WF 130Hz
SV2.0mm
M2
2.3MHz
5.0cm
M3 M4
+30.8
-30.8
cm/s
Vel -322 cm/s
-400
-300
-200
-100
Inv
cm/s
-100
Left DST ANAST
3.6sec


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 10Hz
RP
2D
34%
C 55
P Med
HGen
CF
61%
1816Hz
WF 99Hz
Med
M3 M4
+25.4
-25.4
cm/s
9.0
Left TIB-PERO TRUNK


HJ E107172914 Johns Hopkins Vasc Lab L9-3/Vasc Art
FR 9Hz 60°
P1
2D
55%
C 50
P Low
Gen
CF
69%
5250Hz
WF 210Hz
Med
PW
64%
WF 70Hz
SV1.5mm
M2
3.5MHz
4.6cm
M2 M3
+57.8
-57.8
cm/s
Vel -196 cm/s
7.0
-240
-160
-80
Inv
cm/s
-80
3.6sec
Left OUTFLOW BK POP A


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 11Hz 60°
RP
2D
34%
C 55
P Med
HGen
CF
61%
1982Hz
WF 108Hz
Med
PW
48%
WF 100Hz
SV2.0mm
M2
2.3MHz
4.1cm
M3 M4
+25.4
-25.4
cm/s
Vel -83.9 cm/s
9.0
-120
-60
Inv
cm/s
-60
3.6sec
Left TIB-PERO TRUNK


HJ E107172914 Johns Hopkins Vasc Lab C5-1/Abd Vasc
FR 10Hz
RP
2D
34%
C 55
P Med
HGen
CF
61%
2200Hz
WF 109Hz
Med
M3 M4
+30.8
-30.8
cm/s
9.0
Left DST ANAST

Case #2
Follow-up Bilateral Lower Extremity Arterial Duplex 2/17/2020

- Left lower extremity arterial duplex demonstrated a patent left distal superficial femoral artery to below-knee popliteal artery bypass. There is however, elevated flow velocities at the distal anastomosis with low flow velocities within the bypass graft.

JOHNS HOPKINS MEDICINE

Case #2
Unforeseen circumstances

- Due to high velocities at the distal anastomosis site and slow flow within the bypass graft, the vascular surgeon advised patient to return for a 3 month follow-up.
- Covid-19 lead to shutdown of outpatient clinics but even after re-opening in the summer, patient feared to return for follow-ups until new onset of left lower extremity calf claudication the following year.

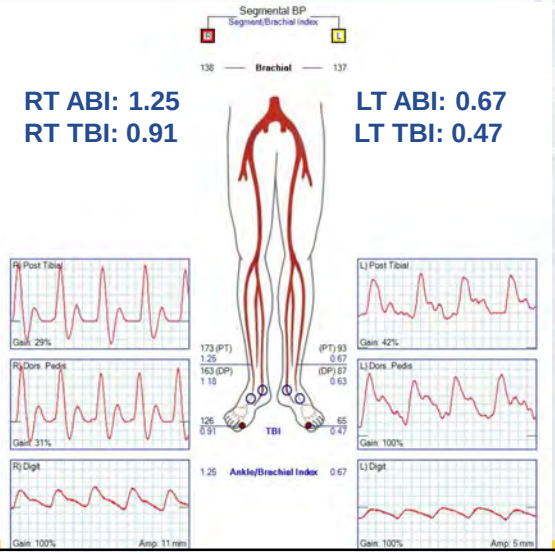
JOHNS HOPKINS MEDICINE

ABI
2/22/2021

Prior Exam
RT ABI: 1.29 LT ABI: 1.02
RT TBI: 0.87 LT TBI: 0.86

RT ABI: 1.25
RT TBI: 0.91

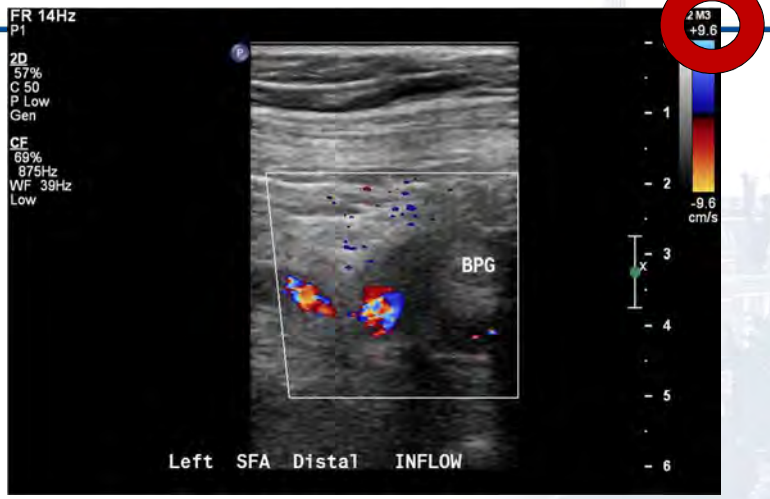
LT ABI: 0.67
LT TBI: 0.47



JOHNS HOPKINS MEDICINE

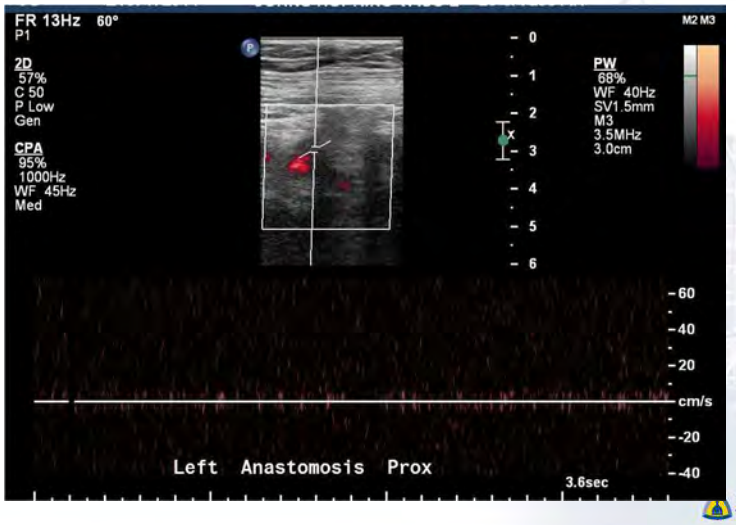
Left lower arterial duplex
2/22/2021

JOHNS HOPKINS MEDICINE

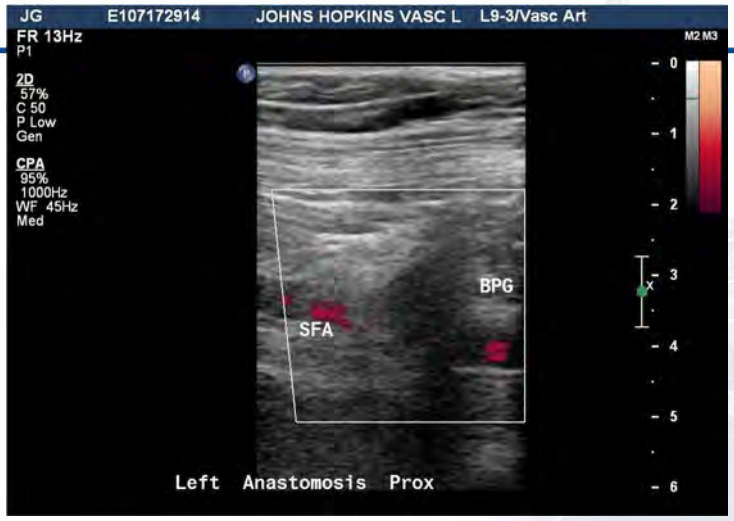


JOHNS HOPKINS MEDICINE

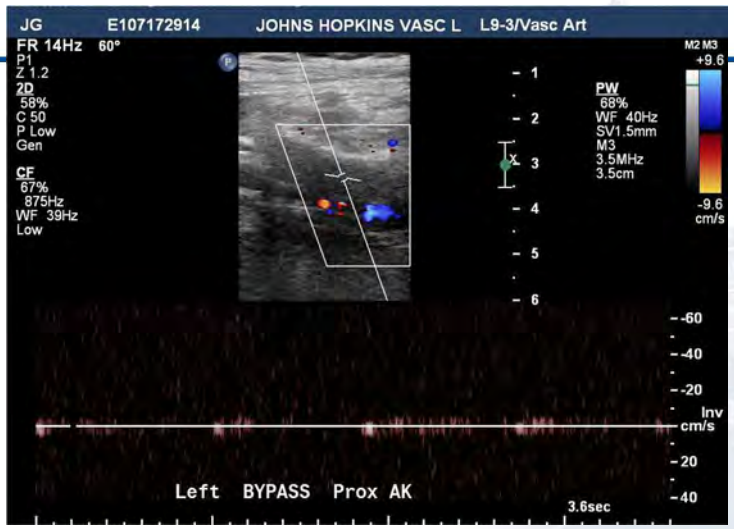
JOHNS HOPKINS MEDICINE



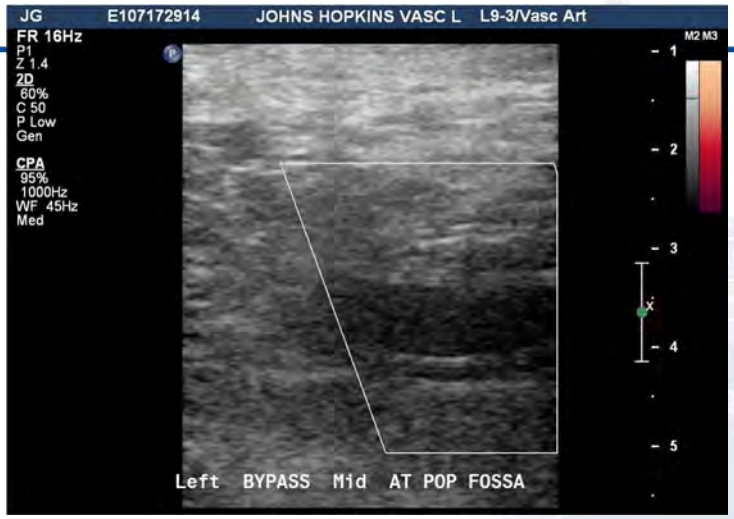
JOHNS HOPKINS MEDICINE



JOHNS HOPKINS MEDICINE

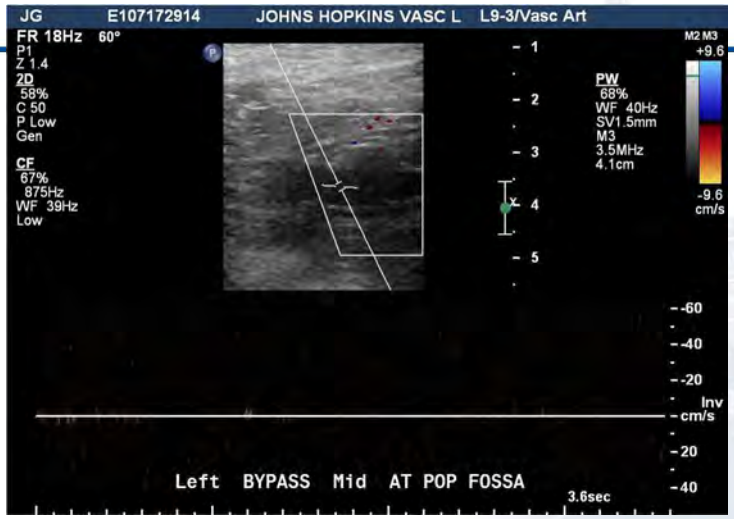

JG
E107172914
JOHNS HOPKINS VASC L
L9-3/Vasc Art
FR 14Hz
60°
P1
Z 1.2
2D
58%
C 50
P Low
Gen
CF
67%
875Hz
WF 39Hz
Low
M2 M3
+9.6
-9.6
cm/s
PW
68%
WF 40Hz
SV1.5mm
M3
3.5MHz
3.5cm
-60
-40
-20
Inv
cm/s
20
40
Left BYPASS Prox AK
3.6sec


JG
E107172914
JOHNS HOPKINS VASC L
L9-3/Vasc Art
FR 27Hz
RS
Z 1.4
2D
68%
C 50
P Low
HGen
M2
Left BYPASS Prox AK

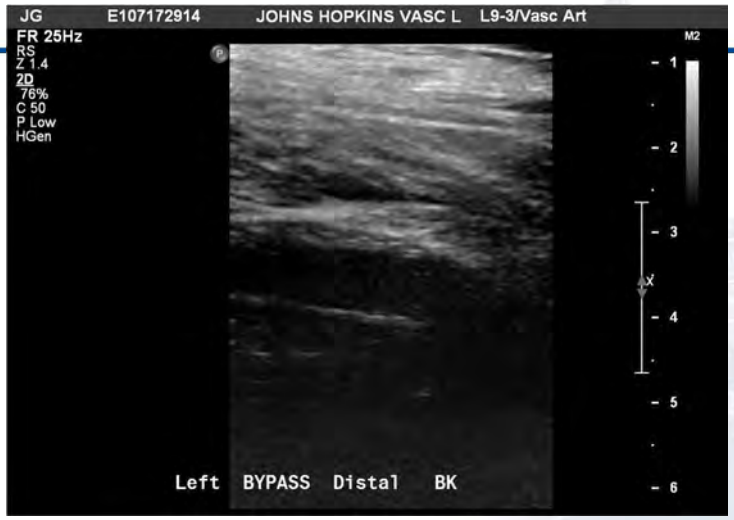


JOHNS HOPKINS MEDICINE

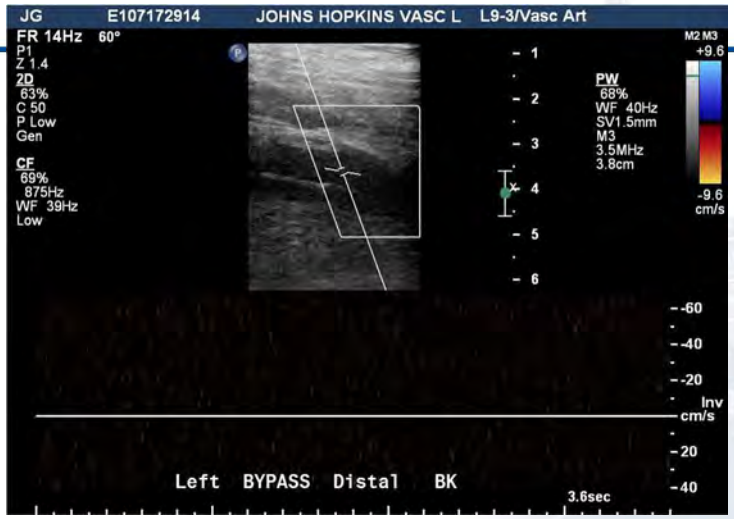
JOHNS HOPKINS MEDICINE



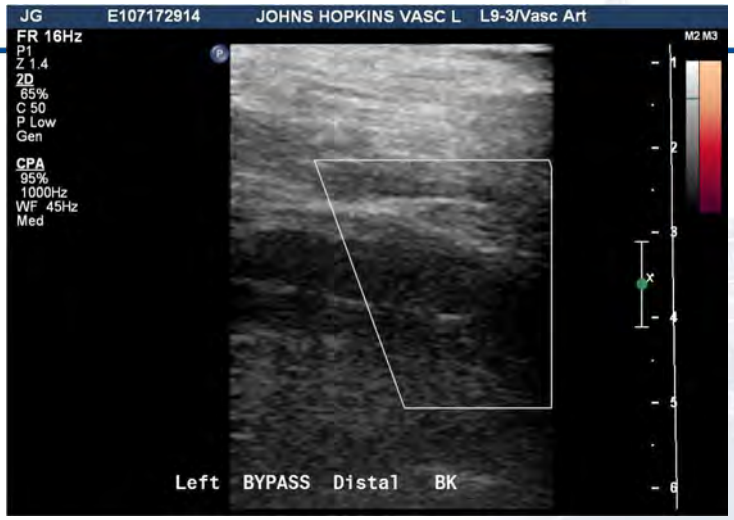
JOHNS HOPKINS MEDICINE



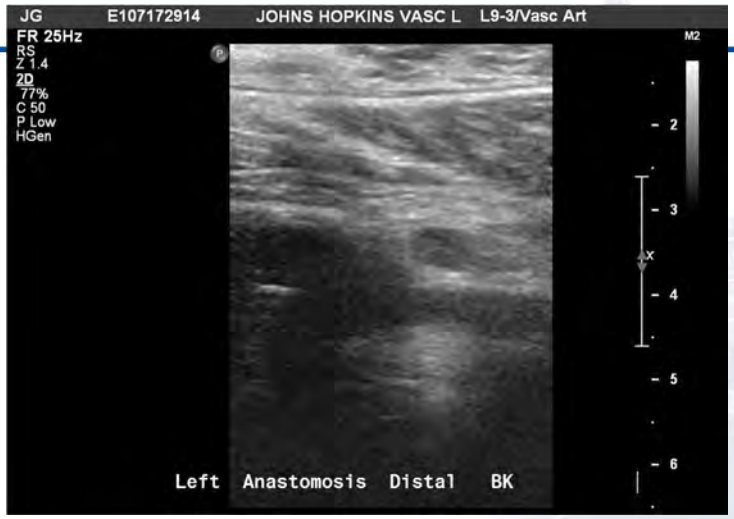
JOHNS HOPKINS MEDICINE

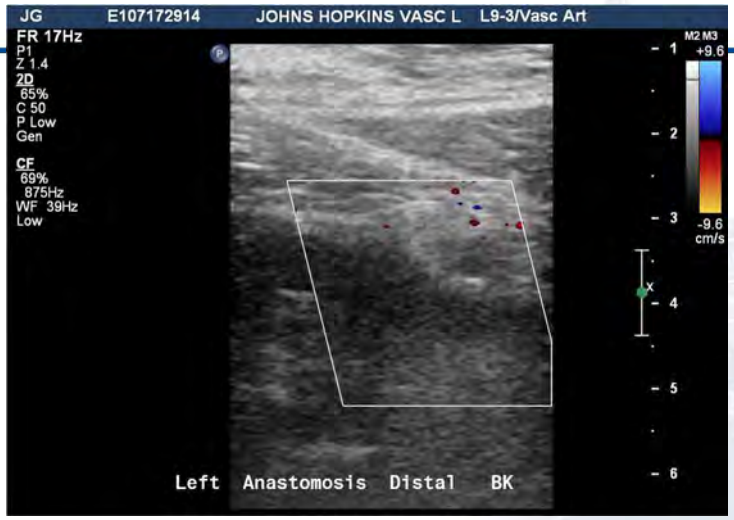


JOHNS HOPKINS MEDICINE

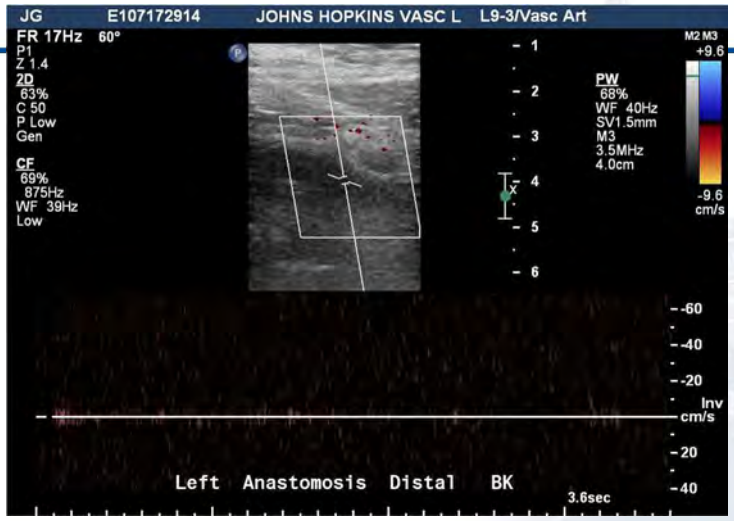


JOHNS HOPKINS MEDICINE

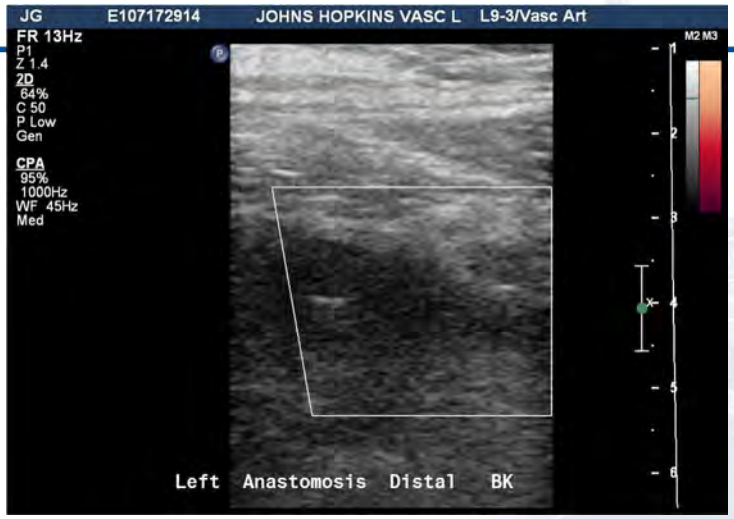

JG
E107172914
JOHNS HOPKINS VASC L
L9-3/Vasc Art
FR 25Hz
RS
Z 1.4
2D
77%
C 50
P Low
HGen
M2
2
3
4
5
6
Left Anastomosis Distal BK


JG
E107172914
JOHNS HOPKINS VASC L
L9-3/Vasc Art
FR 17Hz
P1
Z 1.4
2D
65%
C 50
P Low
Gen
CF
69%
875Hz
WF 39Hz
Low
M2 M3
+9.6
-9.6
cm/s
1
2
3
4
5
6
Left Anastomosis Distal BK

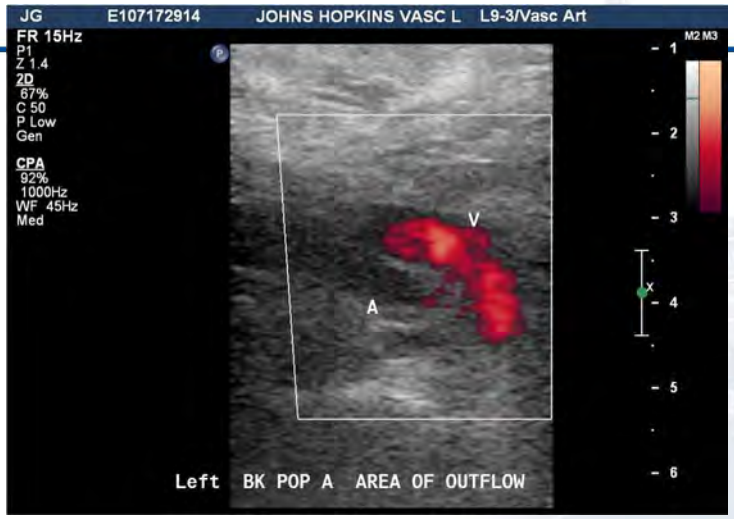
JOHNS HOPKINS MEDICINE



JOHNS HOPKINS MEDICINE


JG E107172914 JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 13Hz
P1
Z 1.4
2D
64%
C 50
P Low
Gen
CPA
95%
1000Hz
WF 45Hz
Med
M2 M3
Left Anastomosis Distal BK


JG E107172914 JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 14Hz 60°
P1
Z 1.4
2D
66%
C 50
P Low
Gen
CF
61%
875Hz
WF 39Hz
Low
PW
52%
WF 40Hz
SV1.5mm
M3
3.5MHz
4.1cm
M2 M3
+9.6
-9.6
cm/s
Inv
cm/s
Left BK POP A AREA OF OUTFLOW
6.6sec


JG
E107172914
JOHNS HOPKINS VASC L
L9-3/Vasc Art
FR 15Hz
P1
Z 1.4
2D
67%
C 50
P Low
Gen
CPA
92%
1000Hz
WF 45Hz
Med
M2 M3
V
A
Left BK POP A AREA OF OUTFLOW


JG
E107172914
JOHNS HOPKINS VASC L
L9-3/Vasc Art
FR 12Hz 60°
P1
Z 0.8
2D
61%
C 50
P Low
Gen
CF
63%
875Hz
WF 39Hz
Low
PW
64%
WF 40Hz
SV1.5mm
M3
3.5MHz
3.3cm
M2 M3
+9.6
-9.6
cm/s
Vel 22.9 cm/s
-40
-20
cm/s
-20
Left PTA Prox
6.6sec

JOHNS HOPKINS MEDICINE

Left lower arterial duplex 2-22-2021

Left lower extremity arterial duplex evaluation demonstrated an **occluded left femoral–popliteal bypass graft.** There was normal flow in the left common femoral artery with a very mild elevation of the peak systolic velocity in the proximal left superficial femoral artery. There was sluggish flow in the left posterior tibial and peroneal arteries.

When compared to the previous examination of February 17, 2020, there has been the development of occlusion of the left femoral-popliteal bypass graft with a marked reduction of left lower extremity perfusion noted on the current study.

JOHNS HOPKINS MEDICINE

Case #3

JOHNS HOPKINS MEDICINE

Case #3

64 yo female presents for routine surveillance of left popliteal artery stent with new in-stent stenosis.

- Relevant patient history
  - DM
  - HTN
  - Left popliteal artery stenosis
- Relevant surgical history
  - Left popliteal artery stenosis with endartectomy, angioplasty, then stenting

JOHNS HOPKINS MEDICINE

Case #3
Outline

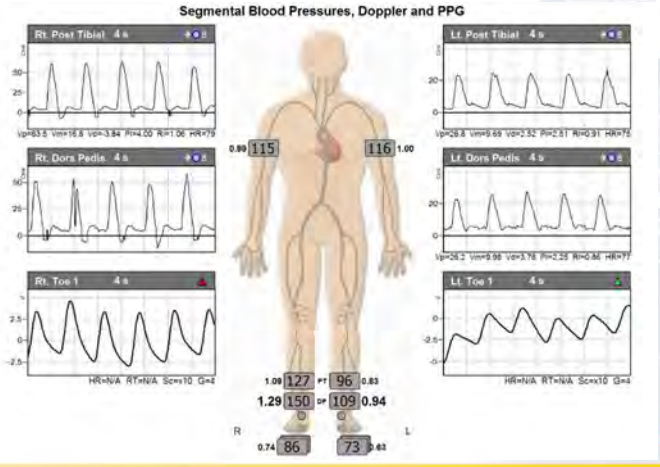
- Routine ABI + left lower extremity duplex - 10/18/2017
- Angiography + Intervention - 1/9/2018
- Follow-up ABI + left lower arterial duplex - 2/21/2018

JOHNS HOPKINS MEDICINE

ABI
10/18/2017

RT ABI: 1.29
RT TBI: 0.74

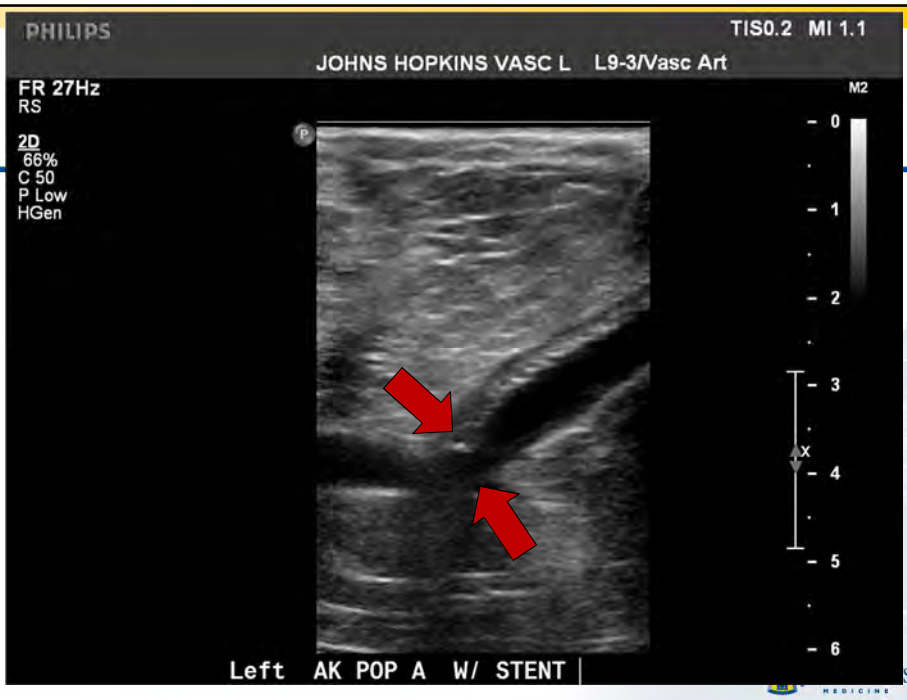
LT ABI: 0.94
LT TBI: 0.63



JOHNS HOPKINS MEDICINE

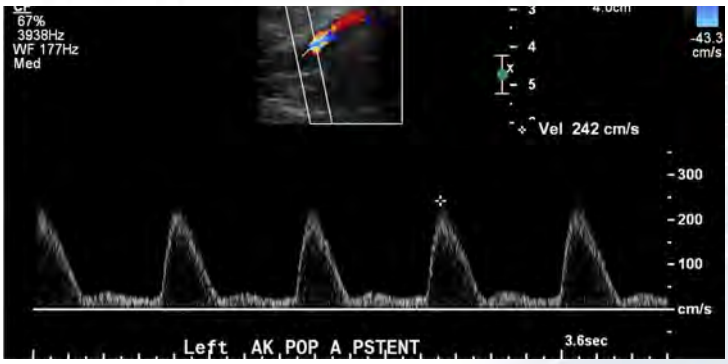
Left Lower Extremity Arterial Duplex
10/18/2017


PHILIPS
TIS0.5 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 9Hz
P1
2D
54%
C 50
P Low
Gen
CF
67%
2625Hz
WF 91Hz
Med
M2 M3
+28.9
-28.9
cm/s
0
1
2
3
4
5
6
Left AK POP A


PHILIPS
TIS0.2 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 27Hz
RS
2D
66%
C 50
P Low
HGen
M2
0
1
2
3
4
5
6
Left AK POP A W/ STENT

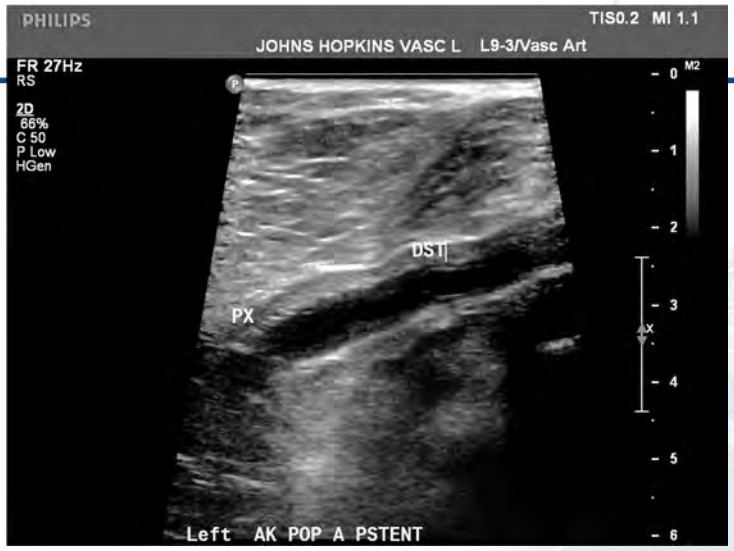
JOHNS HOPKINS MEDICINE

Degree of Stenosis in %	Stenosis 50-69%	Stenosis 70-99%
Duplex Velocity PSV/EDV cm/sec	≥200-300/<45	≥300/ >45
Velocity Ratio (PSV max/PSV prox)	2.0-3.0	>3.0

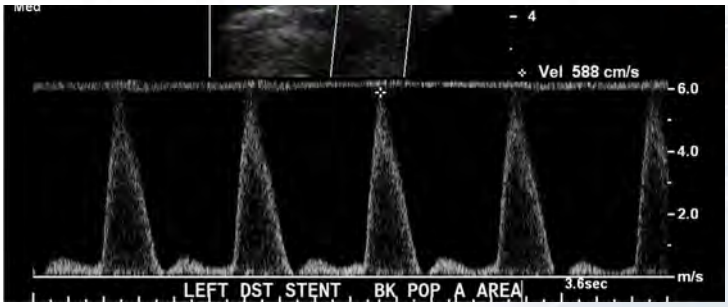


JOHNS HOPKINS MEDICINE

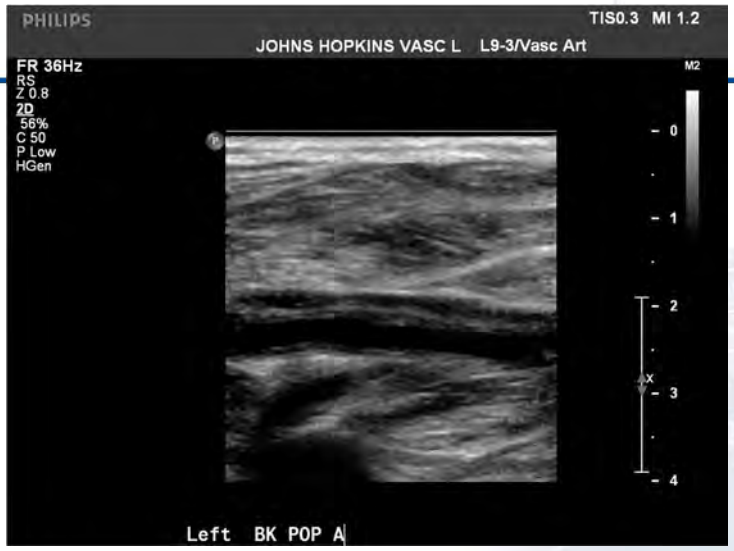

PHILIPS
TIS0.4 MI 0.5
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 13Hz 60°
P1
2D
55%
C 50
P Low
Gen
CF
67%
3938Hz
WF 177Hz
Med
PW
52%
WF 60Hz
SV1.5mm
M2
3.5MHz
3.4cm
M2 M3
+43.3
-43.3
cm/s
Vel 90.4 cm/s
180
120
60
cm/s
-60
Left AK POP A PSTENT
3.6sec


PHILIPS
TIS0.2 MI 1.1
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 27Hz
RS
2D
66%
C 50
P Low
HGen
M2
DST
PX
Left AK POP A PSTENT

Degree of Stenosis in %	Stenosis 50-69%	Stenosis 70-99%
Duplex Velocity PSV/EDV cm/sec	≥200-300/<45	≥300/ >45
Velocity Ratio (PSV max/PSV prox)	2.0-3.0	>3.0




PHILIPS
TIS0.2 MI 0.4
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 18Hz 60°
P1
Z 1.4
2D
54%
C 50
P Low
Gen
CF
67%
3938Hz
WF 177Hz
Med
PW
60%
WF 80Hz
SV1.5mm
M2
3.5MHz
2.9cm
M2 M3
+43.3
-43.3
cm/s
Vel 174 cm/s
300
200
100
cm/s
-100
PST
Left DST TO STENT BK POP AREA
3.6sec


PHILIPS
TIS0.3 MI 1.2
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 36Hz
RS
Z 0.8
2D
56%
C 50
P Low
HGen
M2
Left BK POP A

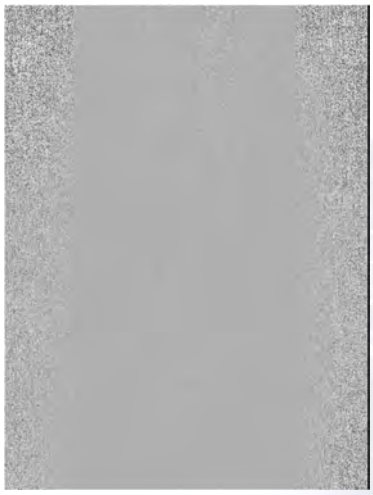
JOHNS HOPKINS MEDICINE

Left lower extremity arterial duplex 10/18/2017

- Arterial duplex evaluation demonstrated a moderate elevation of the peak systolic velocity in the left popliteal artery above the knee suggestive of a 50-69% in-stent stenosis with a marked elevation of the below knee left popliteal artery consistent with a 70-99% in-stent stenosis. There was normal flow in the left common femoral, profunda femoris, and superficial femoral arteries. There was normal flow in the left tibio-peroneal trunk and proximal left posterior tibial artery.
- When compared to the previous examination of June 14, 2017, there has been a slight decline in perfusion to the left leg on the current study.

JOHNS HOPKINS MEDICINE

Left lower extremity angiogram 1/9/2018



JOHNS HOPKINS MEDICINE

Intervention 1/9/2018

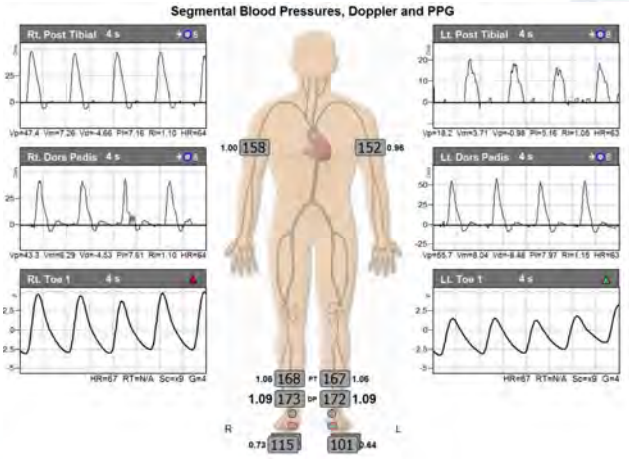
JOHNS HOPKINS MEDICINE

Follow-up ABI 2/21/2018

Prior exam:
RT ABI: 1.29 **LT ABI: 0.94**
RT TBI: 0.74 **LT TBI: 0.63**

RT ABI: 1.09
RT TBI: 0.73

LT ABI: 1.09
LT TBI: 0.64



JOHNS HOPKINS MEDICINE

Left lower extremity arterial duplex 2/21/2018

- Sonographer should perform the required protocol per their lab but should pay extra attention to the surgical intervention sites:
  - popliteal artery s/p angioplasty and atherectomy

JOHNS HOPKINS MEDICINE

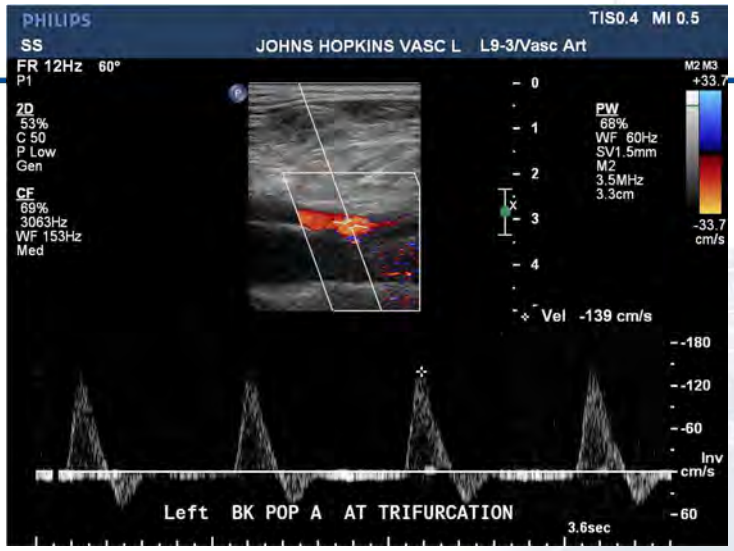

PHILIPS
TIS0.4 MI 0.5
SS
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 13Hz 60°
P1
2D
57%
C 50
P Low
Gen
CF
69%
3500Hz
WF 175Hz
Med
PW
64%
WF 60Hz
SV1.5mm
M2
3.5MHz
4.0cm
M2 M3
+38.5
-38.5
cm/s
Vel 112 cm/s
160
120
80
40
cm/s
-40
Left AK POP A
3.6sec

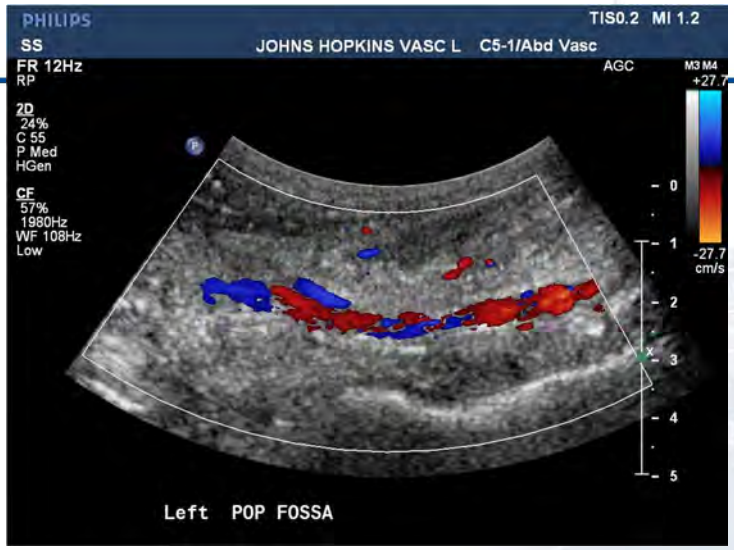

PHILIPS
TIS0.4 MI 0.5
SS
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 13Hz 60°
P1
2D
55%
C 50
P Low
Gen
CF
69%
3500Hz
WF 175Hz
Med
PW
72%
WF 60Hz
SV1.5mm
M2
3.5MHz
3.6cm
M2 M3
+38.5
-38.5
cm/s
Vel 114 cm/s
160
120
80
40
cm/s
-40
Left AK POP A
PX TO STENT
3.6sec

JOHNS HOPKINS MEDICINE

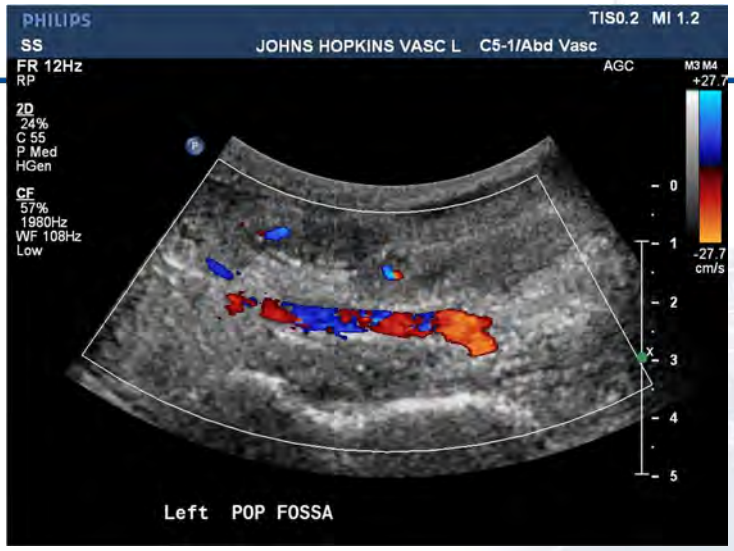
JOHNS HOPKINS MEDICINE


PHILIPS
TIS0.2 MI 0.6
SS
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 17Hz 60°
P1
2D
52%
C 50
P Low
Gen
CF
69%
3063Hz
WF 153Hz
Med
PW
64%
WF 50Hz
SV1.5mm
M2
3.5MHz
2.7cm
M2 M3
+33.7
-33.7
cm/s
Vel 79.2 cm/s
120
80
40
cm/s
-40
Left Pop A
DST TO STENT
3.6sec


PHILIPS
TIS0.4 MI 0.5
SS
JOHNS HOPKINS VASC L L9-3/Vasc Art
FR 12Hz 60°
P1
2D
53%
C 50
P Low
Gen
CF
69%
3063Hz
WF 153Hz
Med
PW
68%
WF 60Hz
SV1.5mm
M2
3.5MHz
3.3cm
M2 M3
+33.7
-33.7
cm/s
Vel -139 cm/s
-180
-120
-60
Inv
cm/s
-60
Left BK POP A AT TRIFURCATION
3.6sec



JOHNS HOPKINS MEDICINE



JOHNS HOPKINS MEDICINE

Follow-up left lower extremity arterial duplex 2/21/2018

Arterial duplex evaluation demonstrated normal flow velocities in the left common femoral, profunda femoris, superficial femoral, and popliteal arteries as well as normal flow at the left tibio-peroneal trunk.

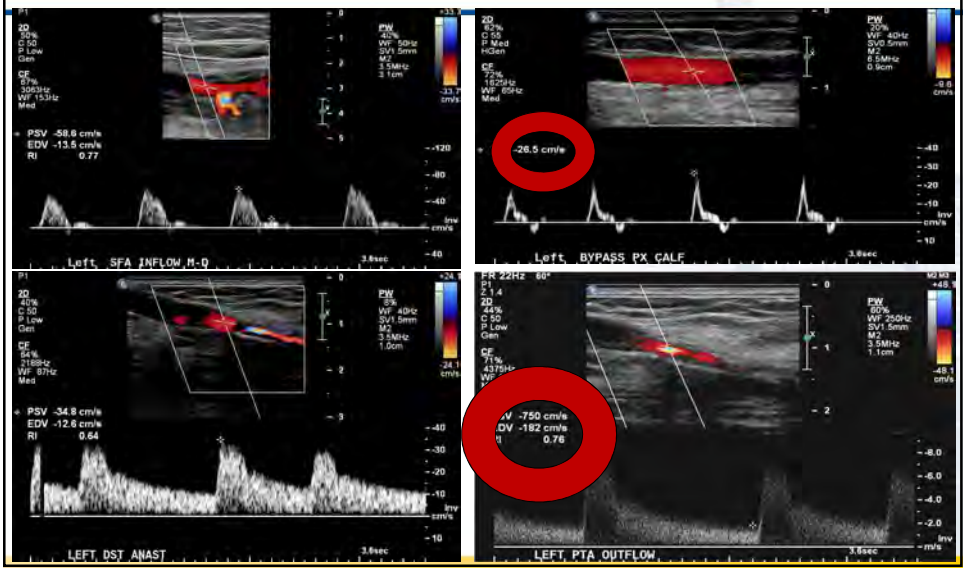
When compared to the previous examination of October 18, 2017 there is improvement to the velocities in the popliteal artery stent.

JOHNS HOPKINS MEDICINE

Q&A

JOHNS HOPKINS MEDICINE

On the basis of the following images, what is your assessment on the bypass graft?



On the basis of the following images, what is your assessment on the bypass graft?

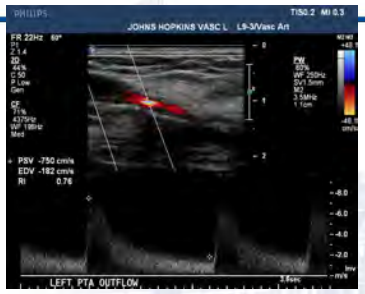
A. Bypass demonstrates normal flow velocities
B. Failing bypass due to outflow disease
C. Wall to wall color fill-in in PTA outflow
D. Failing bypass due to inflow disease

Answer:

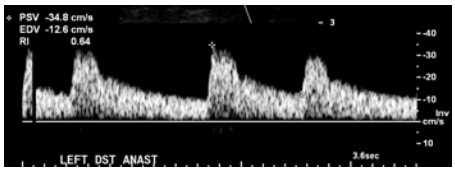
Failing bypass due to outflow disease

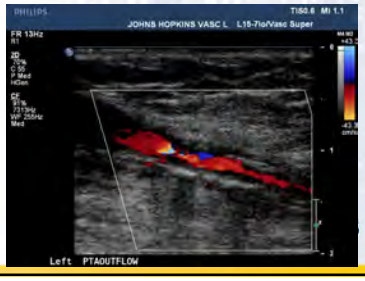
Abnormal Velocity Criteria

- PSV < 40-45 cm/s
- Localized increase in PSV (>120 cm/s)

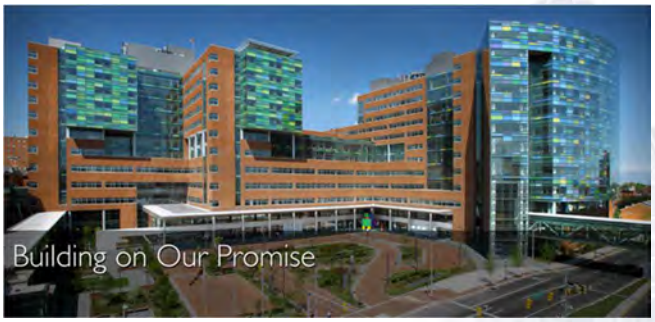


- Monophasic and blunted waveform





Thank you!



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