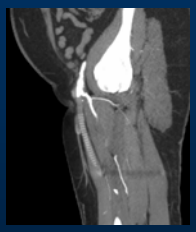
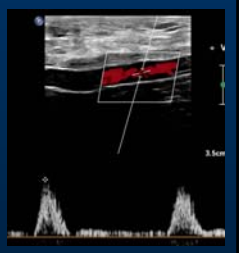
Extremity Bypass Graft Surveillance Using Ultrasound



Mark F. Conrad MD, MMSc



Division of Vascular and Endovascular Surgery
Massachusetts General Hospital, Boston, MA

Disclosures

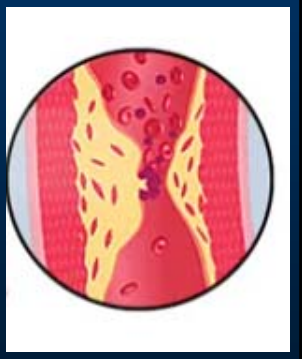
Medtronic – Member of peripheral advisory board, member of CEC

Endologix – consultant

Bard – member of CEC

PAD

- Currently affects 8-12 million Americans
- Estimated to reach 19 million in next 10 years
- Incidence increases with age
- Occurs in 50% of patients >80 years



Clinical Presentation

- Chronic Lower Extremity Ischemia
  - Claudication
- Critical Limb Ischemia
  - Rest Pain
  - Ulceration

Treatment Options

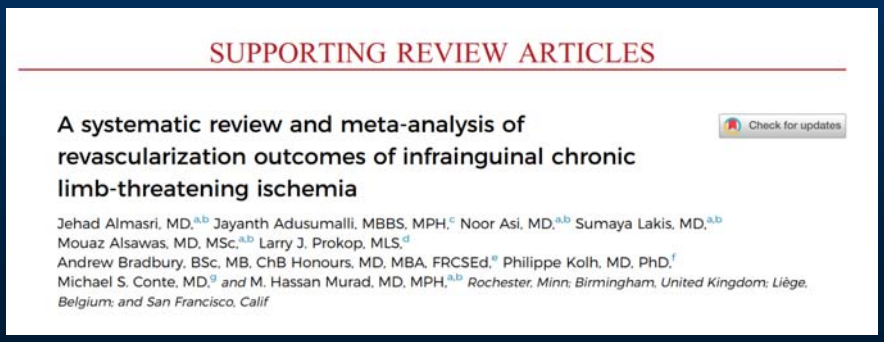
Optimization of medical therapy

Structured walking protocol

Interventions

- Endovascular – PTA/Stent/atherectomy/DCB
- Open – Endarterectomy, Bypass
  - Vein vs Prosthetic Conduit

Outcomes



SUPPORTING REVIEW ARTICLES

A systematic review and meta-analysis of revascularization outcomes of infrainguinal chronic limb-threatening ischemia

Check for updates

Jehad Almasri, MD,[a,b] Jayanth Adusumalli, MBBS, MPH,[c] Noor Asi, MD,[a,b] Sumaya Lakis, MD,[a,b] Mouaz Alsawas, MD, MSc,[a,b] Larry J. Prokop, MLS,[d] Andrew Bradbury, BSc, MB, ChB Honours, MD, MBA, FRCSEd,[e] Philippe Kolh, MD, PhD,[f] Michael S. Conte, MD,[g] *and* M. Hassan Murad, MD, MPH,[a,b] *Rochester, Minn; Birmingham, United Kingdom; Liège, Belgium; and San Francisco, Calif*

Outcomes

1 Year primary patency
77% Prosthetic grafts
64% GSV grafts
45% Spliced arm/ Ectopic vein

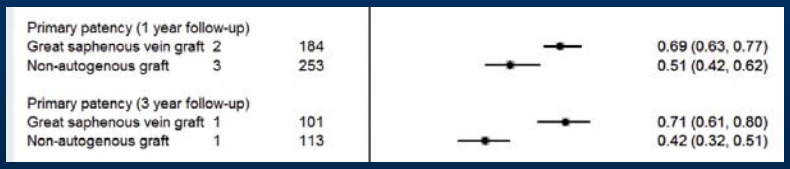
SU

A systematic revi
revascularization outcom
limb-threatening isch

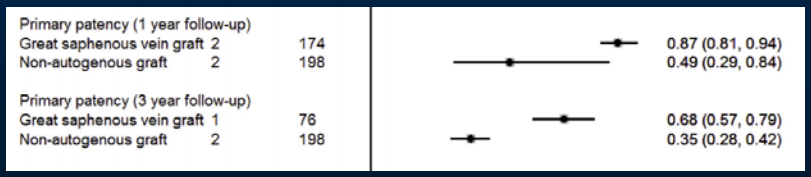
Jehad Almasri, MD,[a,b] Jaya
Mouaz Alsawas, MD, M
Andrew Bradbury, BSc, MB, ChB Honours, MD, MBA, FRCSEd,[e] Philippe Kolh, MD, PhD,[f]
Michael S. Conte, MD,[g] *and* M. Hassan Murad, MD, MPH,[a,b] *Rochester, Minn; Birmingham, United Kingdom; Liège, Belgium; and San Francisco, Calif*

Outcomes

Below-knee Popliteal



Infra-popliteal



Mechanisms of Failure

Inadequate Inflow

- Progression of disease vs Anastomosis

Inadequate Outflow

- Runoff vs distal anastomosis

Conduit Problems

- Alternative veins prone to intrinsic problems

Timing of Failure

Early (30 days)

- usually technical issue or conduit problem

Midterm (30 days – 24 months)

- intimal hyperplasia

Late (> 24 months)

- progression of disease

Goals of Duplex Surveillance

Confirm graft patency

Identify stenotic lesions

Assess risk of graft thrombosis

Monitor stenosis progression

Surveillance Protocol

Clinical Assessment

- Symptoms of recurrent ischemia
- Femoral and pedal pulse exam
- ABI

Color Doppler imaging of entire bypass

- Adjacent inflow/outflow arteries
- Characterize hemodynamics of graft flow

Graft Flow

Characterized by Peak systolic velocities (PSV) along the length of the graft (cm/sec)

Pulsed-Doppler beam with angle of 60° or less

Calculate mean systolic graft flow velocity

- Average PSV from 2/3 nonstenotic graft sites
- Correlates with volume of flow

Graft Flow

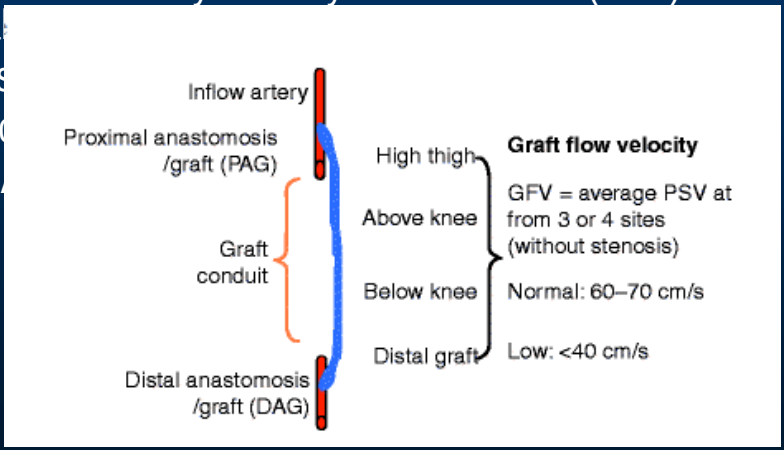
Characterized by Peak systolic velocities (PSV) a

Puls

Calc

-

-

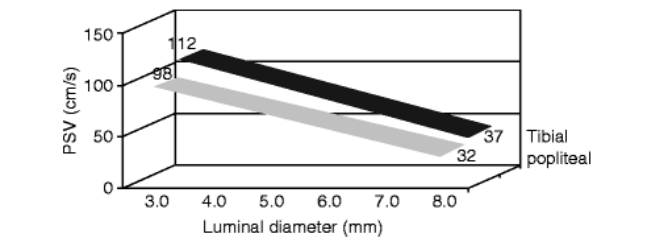


Graft Flow

Low <40cm/s

- Threatened graft
- Larger lumen (>6mm)
- Pedal/ isolated tibial vessel

Normal 60-70cm/sec



Stenosis

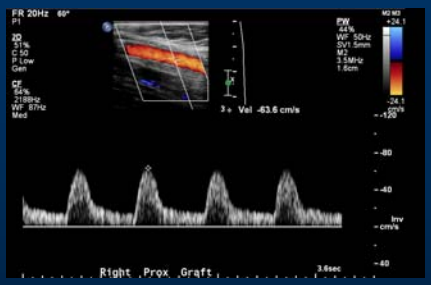
If stenosis is noted by color Doppler imaging

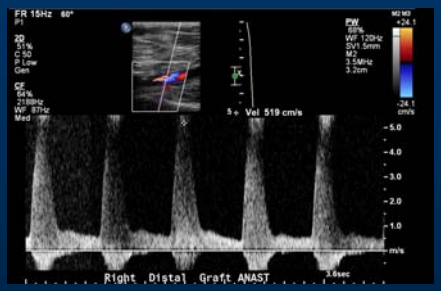
- Measure PSV
- Measure Velocity ratio (Vr)
- Measure lesion length
- Measure vessel diameter

High grade stenosis (>70%)

- PSV >300cm/sec
- EDV >20cm/sec
- Prestenosis/stenosis ratio = >3.5

Stenosis





PSV = 519 cm/s
Vr = PSVmax/PSVprox = 519/64 = 8.1
Lesion length = 2cm
Vessel diameter = 5mm

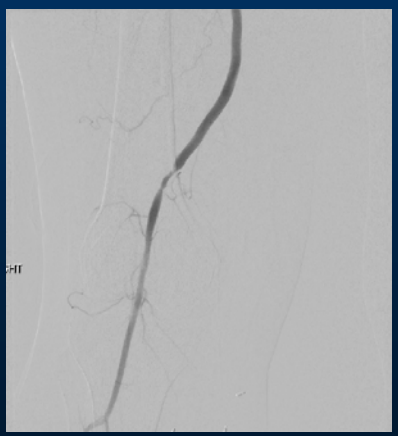
Risk Stratification for Graft Thrombosis

Category	High-Velocity Criteria	Low-Velocity Criteria	Change ABI
I (Highest Risk)	PSV >300cm/sec Vr > 3.5	GFV < 45cm/sec	> 0.15
II (High Risk)	PSV > 300cm/sec Vr > 3.5	GFV > 45cm/sec	< 0.15
III (Intermediate risk)	180< PSV > 300 Vr > 2.0	GFV > 45cm/sec	<0.15
IV (Low Risk)	PSV <180 cm/sec Vr <2.0	GFV >45 cm/sec	<0.15

Treatment Recommendations

Category	Recommendation
I (Highest Risk)	Pressure reducing stenosis with low flow levels below thrombotic threshold – Prompt repair
II (High Risk)	Pressure reducing stenosis but graft flow maintained – Elective repair
III (Intermediate risk)	Not pressure or flow reducing – More frequent serial scanning
IV (Low Risk)	Not pressure or flow reducing – Continue normal surveillance protocol

Angiogram



Early Post-op Stenosis

Graft stenosis detected at 3 months
- About 1/3 of cases will regress
- 40% stay the same or progress to high grade stenosis

Obtain follow up imaging at 6 months
- Graft threatening lesions
    - Quick progression to severity
    - Increased surface thrombus
    - Reduced graft flow
- If no change or improved at 6 months – not likely to be an issue

Incidence of stenosis

80% of grafts will be Category IV (no stenosis)

Recommend 6 month surveillance

If no stenosis but GFV < 40cm/sec – need to search inflow and outflow as well

If nothing is identified, consider anticoagulation for graft salvage

GFV <60 cm/sec for prosthetic grafts

Incidence of stenosis

20% of vein bypasses will have category I or II stenosis within the first year

Risk Factors

- Vein caliber
- Spliced vein
- Alternative conduit
- Prior graft revision
- Early graft thrombectomy

Treatment of Graft Stenosis

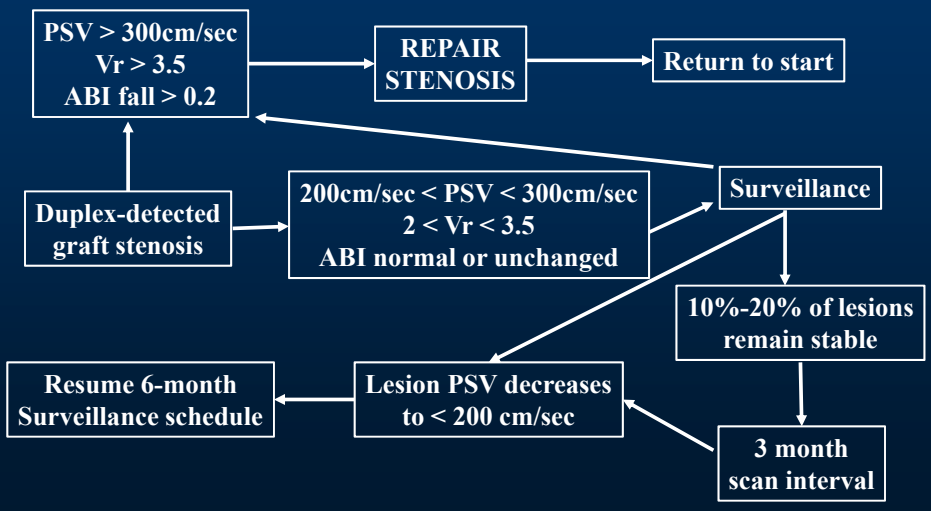
Most are $\leq$ 2cm and can be treated with PTA

If >3 cm - should consider revision

Stenosis free patency at 2 years is 65%

3yr assisted patency is 80% regardless of method of intervention

Surveillance Algorithm for Graft Stenosis



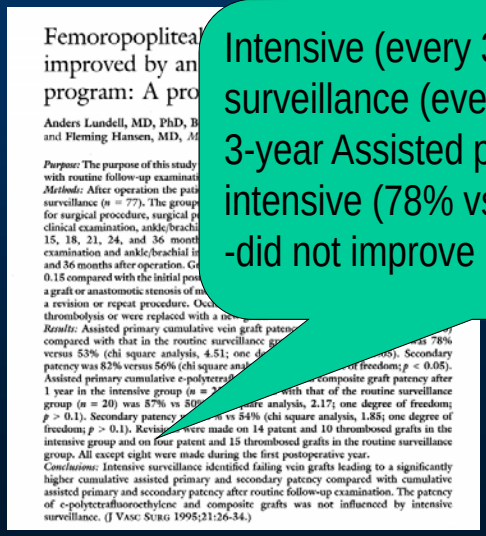
Randomized Trial

Femoropopliteal-crural graft patency is improved by an intensive surveillance program: A prospective randomized study

Anders Lundell, MD, PhD, Bengt Lindblad, MD, PhD, David Bergqvist, MD, PhD and Fleming Hansen, MD, *Malmö, Sweden*

Purpose: The purpose of this study was to evaluate whether intensive surveillance compared with routine follow-up examinations improves femoropopliteal/crural graft patency.
Methods: After operation the patients were randomized to intensive (n = 79) or routine surveillance (n = 77). The groups were matched with regard to sex, diabetes, indication for surgical procedure, surgical procedure, and graft material. Intensive surveillance was clinical examination, ankle/brachial index measurements, and duplex scans 1, 3, 6, 9, 12, 15, 18, 21, 24, and 36 months after operation. Routine surveillance was clinical examination and ankle/brachial index measurements without duplex scanning 1, 12, 24, and 36 months after operation. Grafts with a decrease in ankle/brachial index of more than 0.15 compared with the initial postoperative ankle/brachial index or a duplex scan showing a graft or anastomotic stenosis of more than 50% underwent angiography and if necessary, a revision or repeat procedure. Occluded grafts were reopened with thrombectomy or thrombolysis or were replaced with a new graft.
Results: Assisted primary cumulative vein graft patency in the intensive group (n = 56) compared with that in the routine surveillance group (n = 50) after 3 years was 78% versus 53% (chi square analysis, 4.51; one degree of freedom; $p < 0.05$). Secondary patency was 82% versus 56% (chi square analysis, 5.62; one degree of freedom; $p < 0.05$). Assisted primary cumulative e-polytetrafluoroethylene and composite graft patency after 1 year in the intensive group (n = 23) compared with that of the routine surveillance group (n = 20) was 87% vs 80% (chi square analysis, 2.17; one degree of freedom; $p > 0.1$). Secondary patency was 67% vs 54% (chi square analysis, 1.85; one degree of freedom; $p > 0.1$). Revisions were made on 14 patent and 10 thrombosed grafts in the intensive group and on four patent and 15 thrombosed grafts in the routine surveillance group. All except eight were made during the first postoperative year.
Conclusions: Intensive surveillance identified failing vein grafts leading to a significantly higher cumulative assisted primary and secondary patency compared with cumulative assisted primary and secondary patency after routine follow-up examination. The patency of e-polytetrafluoroethylene and composite grafts was not influenced by intensive surveillance. (J Vasc Surg 1995;21:26-34.)

Randomized Trial



Femoropoplitea
improved by an
program: A pro

Anders Lundell, MD, PhD, B
and Fleming Hansen, MD, M

Purpose: The purpose of this study
with routine follow-up examinati
Methods: After operation the pati
surveillance (n = 77). The group
for surgical procedure, surgical p
clinical examination, ankle/brachi
15, 18, 21, 24, and 36 month
examination and ankle/brachial in
and 36 months after operation. Gr
0.15 compared with the initial pos
a graft or anastomotic stenosis of m
a revision or repeat procedure. Occ
thrombolysis or were replaced with a
Results: Assisted primary cumulative vein graft patenc
compared with that in the routine surveillance gr
versus 53% (chi square analysis, 4.51; one d
patency was 82% versus 56% (chi square ana
Assisted primary cumulative e-polytetra
1 year in the intensive group (n = 2
group (n = 20) was 87% vs 80%
$p > 0.1$). Secondary patency
freedom; $p > 0.1$). Revisi
intensive group and on four patent and 15 thrombosed grafts in the routine surveillance group. All except eight were made during the first postoperative year.
Conclusions: Intensive surveillance identified failing vein grafts leading to a significantly higher cumulative assisted primary and secondary patency compared with cumulative assisted primary and secondary patency after routine follow-up examination. The patency of e-polytetrafluoroethylene and composite grafts was not influenced by intensive surveillance. (J Vasc Surg 1995;21:26-34.)

Intensive (every 3 months) vs routine surveillance (every 12 months)
3-year Assisted patency higher with intensive (78% vs 53% p<0.05)
-did not improve PTFE patency

Systemic Review

Systematic review and meta-analysis of duplex ultrasound surveillance for infrainguinal vein bypass grafts

Abd Moain Abu Dabrh, MBBCh, MS,[a,b] Khaled Mohammed, MBBCh, MPH,[a] Wigdan Farah, MBBS,[a] Qusay Haydour, MD,[a] R. Eugene Zierler, MD, RPVI, FACS,[c] Zhen Wang, PhD,[a] Larry J. Prokop, MLS,[d] *and* M. Hassan Murad, MD, MPH,[a] *Rochester, Minn; Jacksonville, Fla; and Seattle, Wash*

ABSTRACT

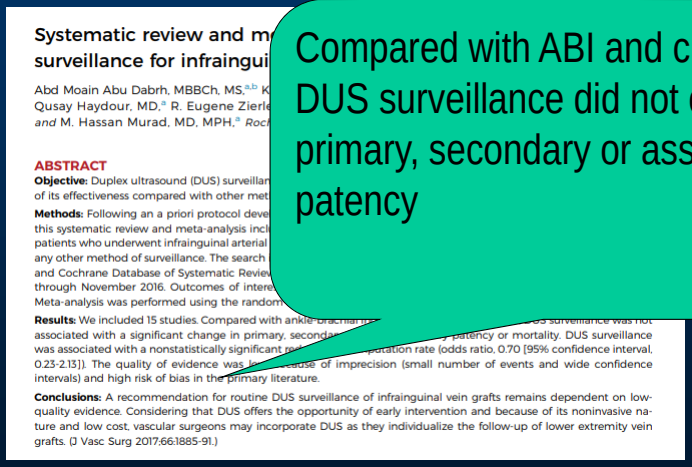
Objective: Duplex ultrasound (DUS) surveillance of infrainguinal vein bypass grafts is widely practiced, but the evidence of its effectiveness compared with other methods of surveillance remains unclear.

Methods: Following an a priori protocol developed by the guidelines committee from the Society for Vascular Surgery, this systematic review and meta-analysis included randomized and nonrandomized comparative studies that enrolled patients who underwent infrainguinal arterial reconstruction and received DUS surveillance for follow-up compared with any other method of surveillance. The search included MEDLINE, Embase, Cochrane Central Register of Controlled Trials and Cochrane Database of Systematic Reviews, Cumulative Index to Nursing and Allied Health Literature, and Scopus through November 2016. Outcomes of interest included all-cause mortality, limb viability, and graft patency reports. Meta-analysis was performed using the random-effects model.

Results: We included 15 studies. Compared with ankle-brachial index and clinical examination, DUS surveillance was not associated with a significant change in primary, secondary, or assisted primary patency or mortality. DUS surveillance was associated with a nonstatistically significant reduction in amputation rate (odds ratio, 0.70 [95% confidence interval, 0.23-2.13]). The quality of evidence was low because of imprecision (small number of events and wide confidence intervals) and high risk of bias in the primary literature.

Conclusions: A recommendation for routine DUS surveillance of infrainguinal vein grafts remains dependent on low-quality evidence. Considering that DUS offers the opportunity of early intervention and because of its noninvasive nature and low cost, vascular surgeons may incorporate DUS as they individualize the follow-up of lower extremity vein grafts. (J Vasc Surg 2017;66:1885-91.)

Systemic Review



Systematic review and m
surveillance for infraingui

Abd Moain Abu Dabrh, MBBCh, MS,[a,b] K
Qusay Haydour, MD,[a] R. Eugene Zierle
and M. Hassan Murad, MD, MPH,[a] Roch

ABSTRACT

Objective: Duplex ultrasound (DUS) surveillan
of its effectiveness compared with other met

Methods: Following an a priori protocol deve
this systematic review and meta-analysis incl
patients who underwent infrainguinal arterial
any other method of surveillance. The search
and Cochrane Database of Systematic Revie
through November 2016. Outcomes of intere
Meta-analysis was performed using the random

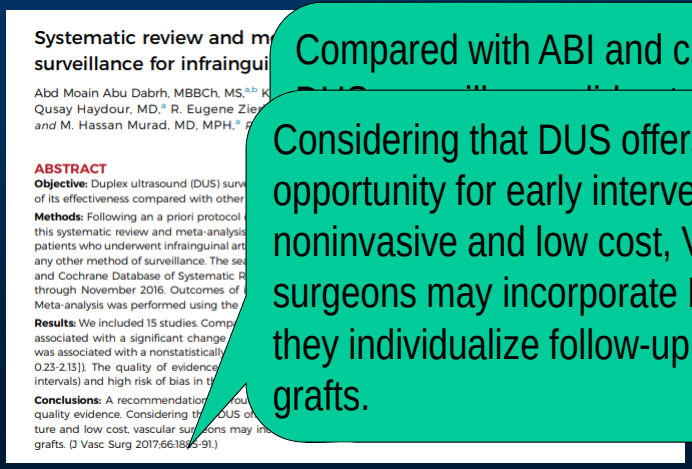
Results: We included 15 studies. Compared with ankle
associated with a significant change in primary, secondar
was associated with a nonstatistically significant red
0.23-2.13]). The quality of evidence was l
intervals) and high risk of bias in the primary literature.

Conclusions: A recommendation for routine DUS surveillance of infrainguinal vein grafts remains dependent on low-quality evidence. Considering that DUS offers the opportunity of early intervention and because of its noninvasive nature and low cost, vascular surgeons may incorporate DUS as they individualize the follow-up of lower extremity vein grafts. (J Vasc Surg 2017;66:1885-91.)

patency or mortality. DUS surveillance
population rate (odds ratio, 0.70 [95% confidence interval,
because of imprecision (small number of events and wide confidence

Compared with ABI and clinical exam, DUS surveillance did not change primary, secondary or assisted patency

Systemic Review



Systematic review and m
surveillance for infraingui

Abd Moain Abu Dabrh, MBBCh, MS,[a,b] K
Qusay Haydour, MD,[a] R. Eugene Zie
and M. Hassan Murad, MD, MPH,[a]

ABSTRACT

Objective: Duplex ultrasound (DUS) surv
of its effectiveness compared with other

Methods: Following an a priori protocol
this systematic review and meta-analysis
patients who underwent infrainguinal art
any other method of surveillance. The se
and Cochrane Database of Systematic R
through November 2016. Outcomes of
Meta-analysis was performed using the

Results: We included 15 studies. Comp
associated with a significant change
was associated with a nonstatistically
0.23-2.13]). The quality of evidence
intervals) and high risk of bias in t

Conclusions: A recommendation
quality evidence. Considering th
ture and low cost, vascular su
grafts. (J Vasc Surg 2017;66:1885-91.)

Compared with ABI and clinical exam,

Considering that DUS offers the opportunity for early intervention, it is noninvasive and low cost, Vascular surgeons may incorporate DUS as they individualize follow-up of LE vein grafts.

SVS Guidelines

SOCIETY FOR VASCULAR SURGERY® DOCUMENT

Editors' Choice

The Society for Vascular Surgery practice guidelines on follow-up after vascular surgery arterial procedures

R. Eugene Zierler, MD,[a] William D. Jordan, MD,[b] Brajesh K. Lal, MD,[c] Firas Mussa, MD,[d] Steven Leers, MD,[e] Joseph Fulton, MD,[f] William Pevec, MD,[g] Andrew Hill, MD,[h] *and* M. Hassan Murad, MD, MPH,[i] *Seattle, Wash; Atlanta, Ga; Baltimore, Md; Columbia, SC; Pittsburgh, Pa; Poughkeepsie, NY; Sacramento, Calif; Ottawa, Ontario, Canada; and Rochester, Minn*

ABSTRACT

Although follow-up after open surgical and endovascular procedures is generally regarded as an important part of the care provided by vascular surgeons, there are no detailed or comprehensive guidelines that specify the optimal approaches with regard to testing methods, indications for reintervention, and follow-up intervals. To provide guidance to the vascular surgeon, the Clinical Practice Council of the Society for Vascular Surgery appointed an expert panel and a methodologist to review the current clinical evidence and to develop recommendations for follow-up after vascular surgery procedures. For those procedures for which high-quality evidence was not available, recommendations were based on observational studies, committee consensus, and indirect evidence. Recognizing that there are numerous published reports on the role of duplex ultrasound for surveillance of infrainguinal vein bypass grafts, the Society commissioned a systematic review and meta-analysis on this topic.

The panel classified the strength of each recommendation and the corresponding quality of evidence on the basis of the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system: recommendations were graded either *strong* or *weak*, and the quality of evidence was graded *high*, *moderate*, or *low*. The resulting recommendations represent a wide variety of open surgical and endovascular procedures involving the extracranial carotid artery, thoracic and abdominal aorta, mesenteric and renal arteries, and lower extremity arterial revascularization. The panel also identified many areas in which there was a lack of high-quality evidence to support their recommendations. This suggests that there are opportunities for further clinical research on testing methods, threshold criteria, and the role of surveillance as well as on the modes of failure and indications for reintervention after vascular surgery procedures. (J Vasc Surg 2018;68:256-84.)

Keywords: Surveillance; Duplex imaging; Postoperative follow-up; Clinical guidelines

SVS Guidelines

5. Based on the high prevalence of abnormalities detected by DUS as well as the relatively low associated cost and risks, we recommend clinical examination, ABI, and DUS for infrainguinal vein graft surveillance. This should include an early postoperative baseline evaluation and follow-up at 3, 6, and 12 months and at least annually thereafter. More frequent surveillance may be considered when uncorrected abnormalities are identified on DUS or when alternative vein conduits (other than great saphenous vein) are used.

   Strength of Recommendation: 1 (Strong)

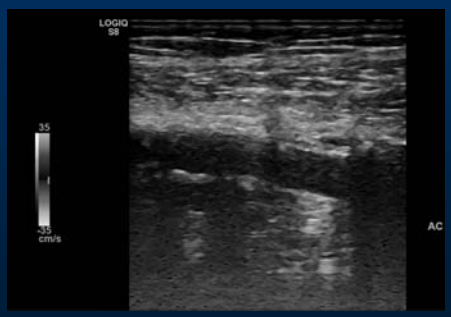
   Quality of Evidence: B (Moderate)

6. After prosthetic infrainguinal bypass grafts, we recommend clinical examination and ABI, with or without the addition of DUS, in the early postoperative period to provide a baseline for further follow-up.This evaluation should be repeated at 6 and 12 months and then annually as long as there are no new signs or symptoms.

   Strength of Recommendation: 1 (Strong)

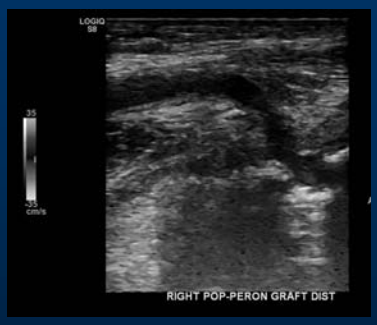
   Quality of Evidence: B (Moderate)

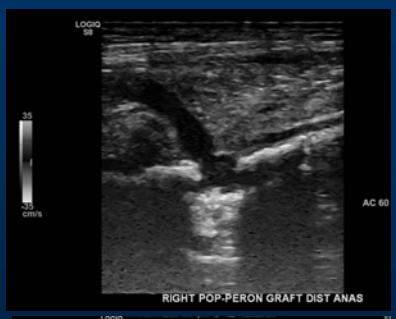
Pop-peroneal bypass with vein



Pop-peroneal bypass with vein

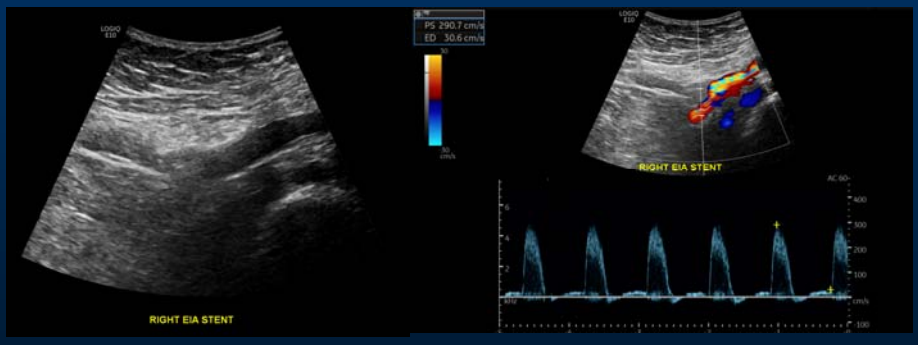
Pop-peroneal bypass with vein



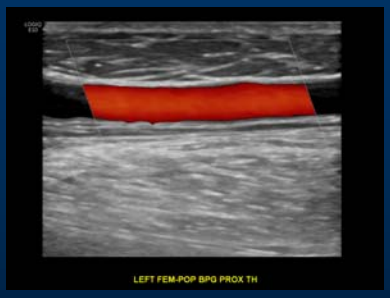


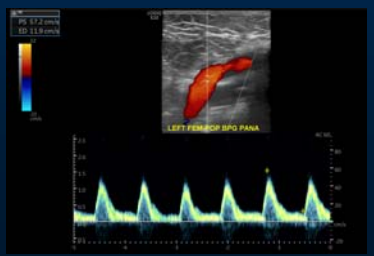
Pop-peroneal bypass with vein

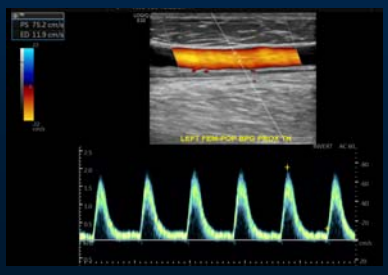
Patent Bypass – EIA Stent



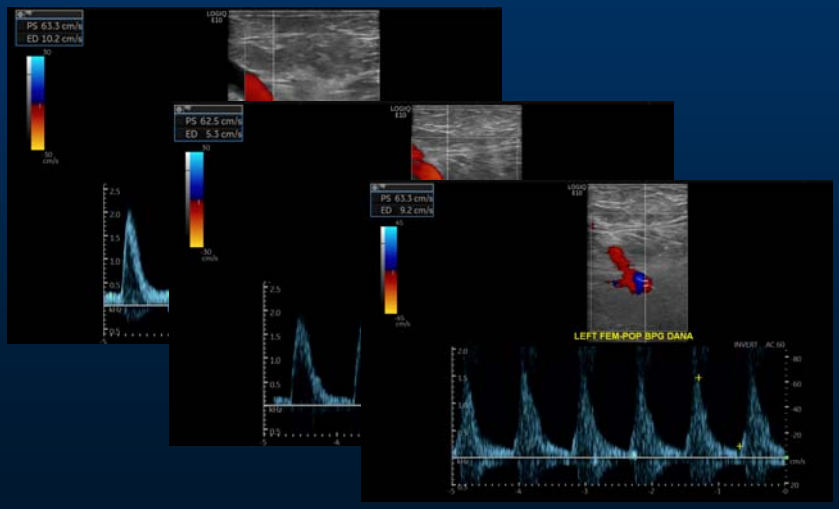
Patent Bypass



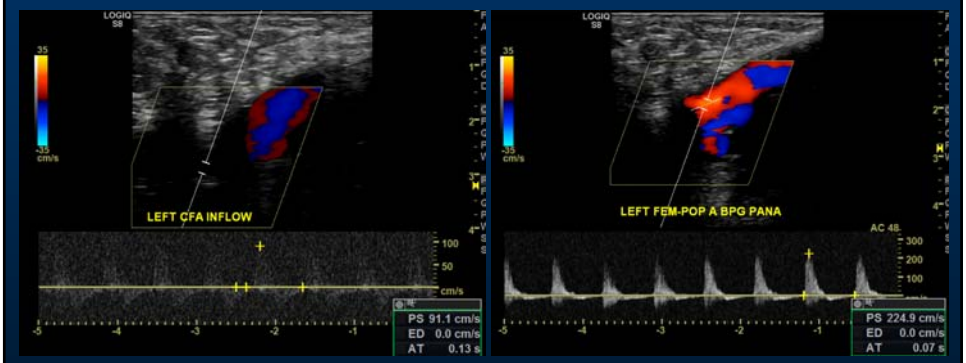




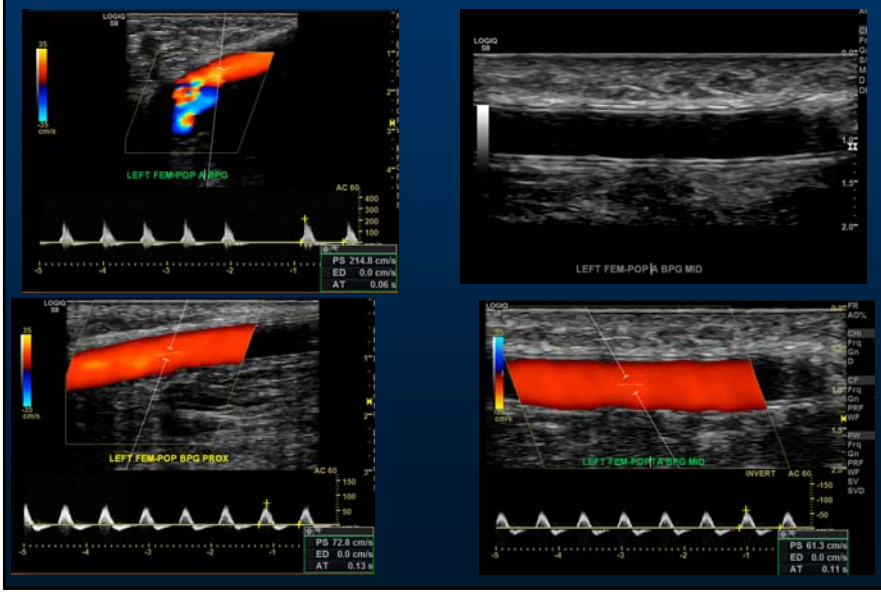
Patent Bypass



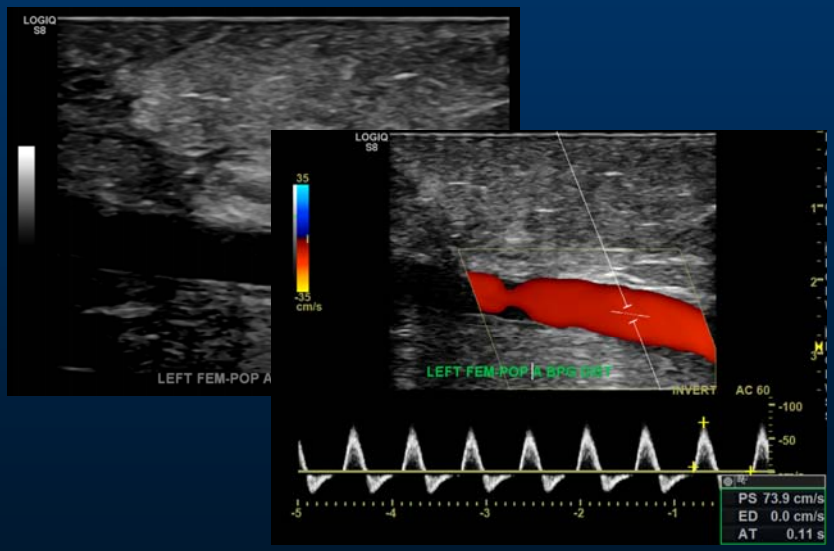
>50% Proximal Stenosis



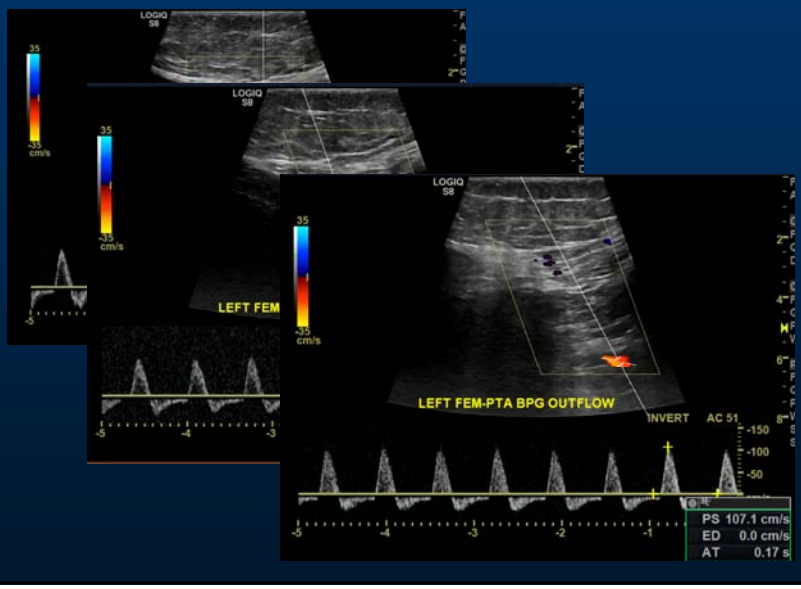
>50% Proximal Stenosis



>50% Proximal Stenosis

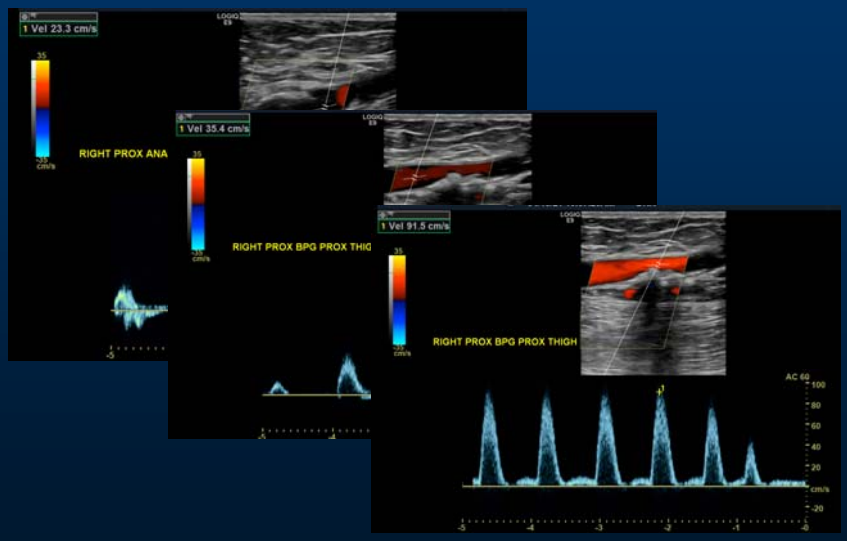


>50% Proximal Stenosis

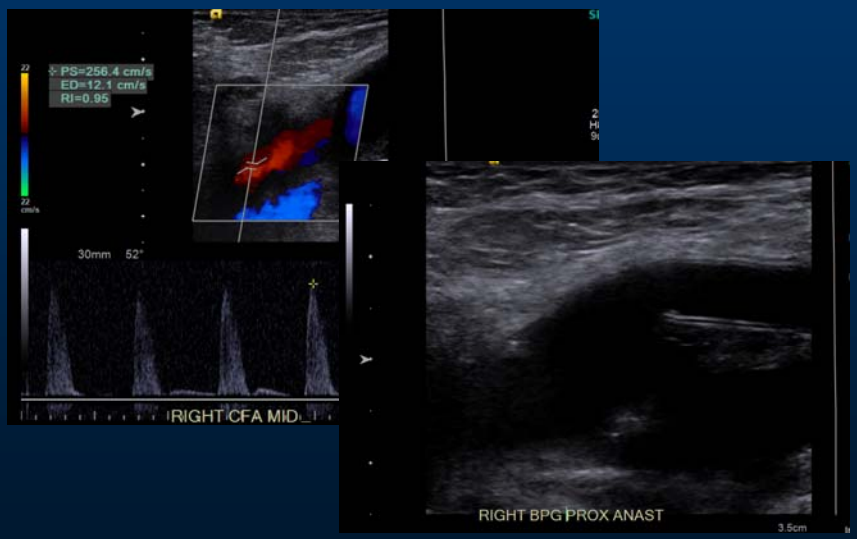


Vein Bypass w/ Proximal Stenosis

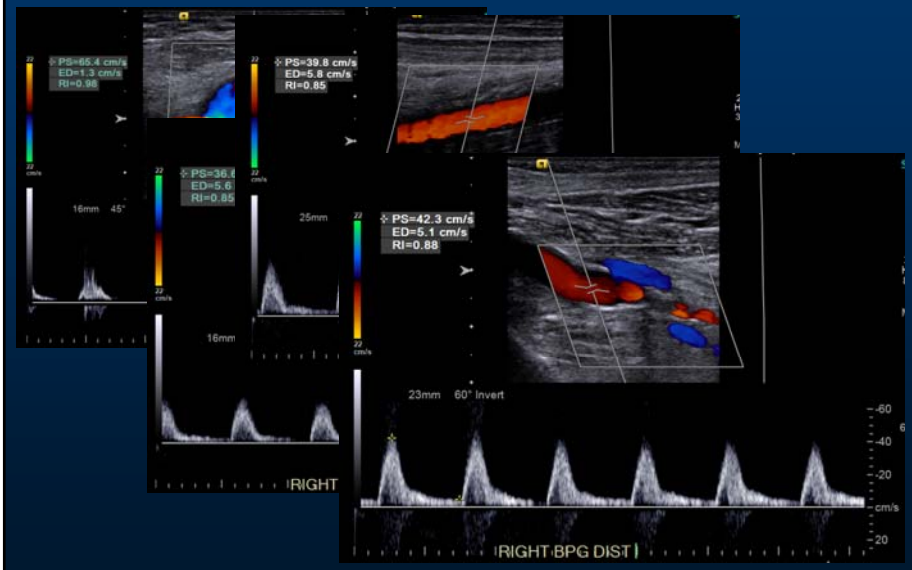
Vein Bypass w/ Proximal Stenosis



PTFE Graft w/ Proximal Stenosis

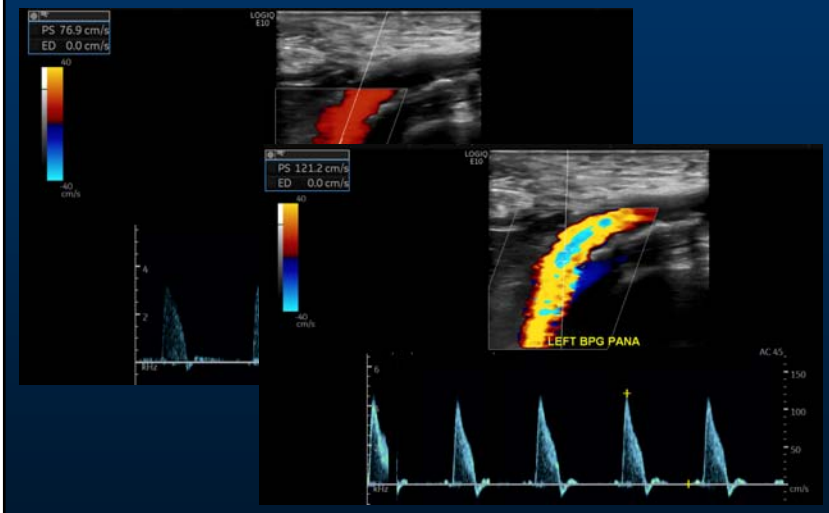


PTFE Graft w/ Proximal Stenosis

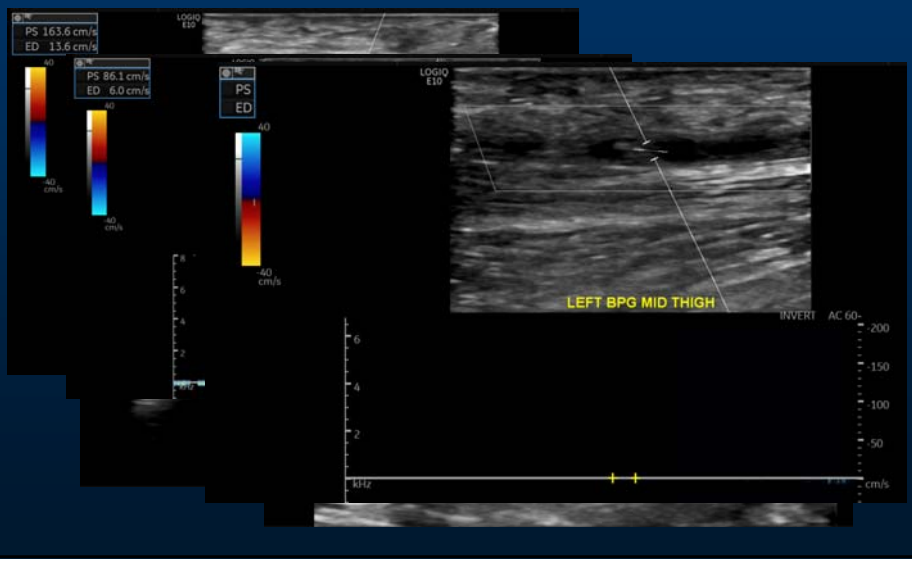


PTFE Graft w/ Proximal Stenosis

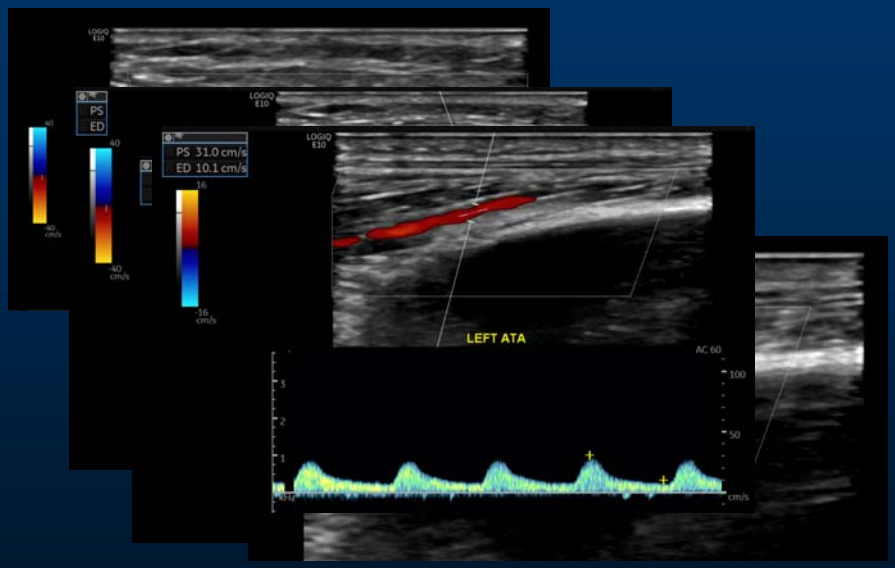
Thrombosed Insitu Vein



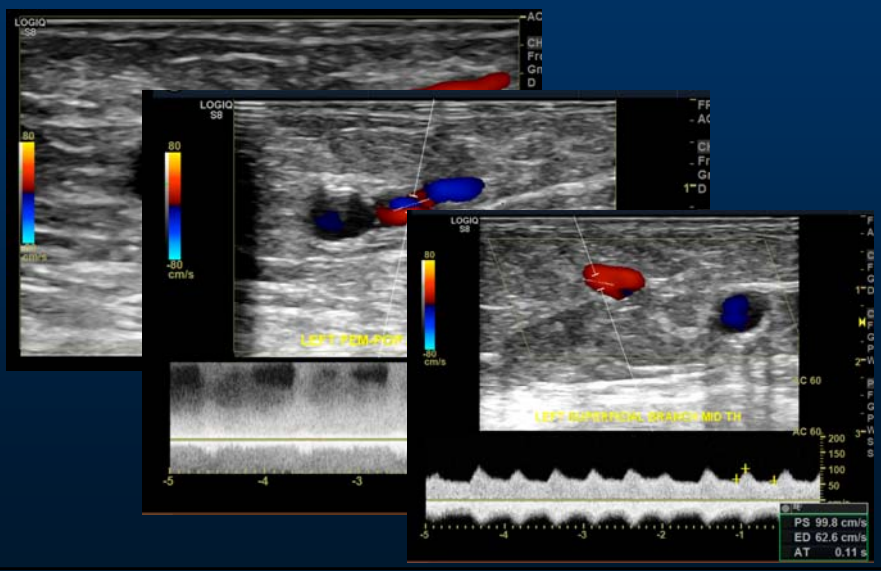
Thrombosed Insitu Vein



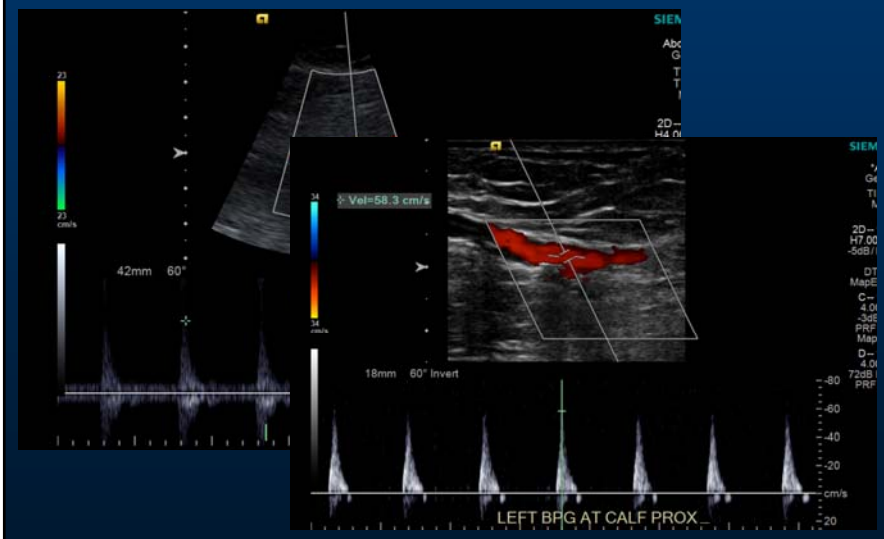
Thrombosed Insitu Vein



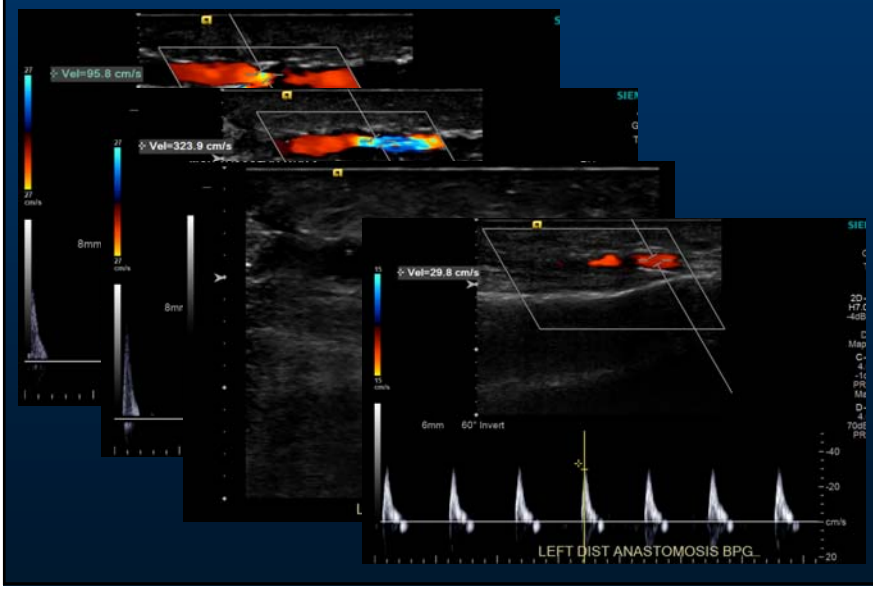
In Situ Branch



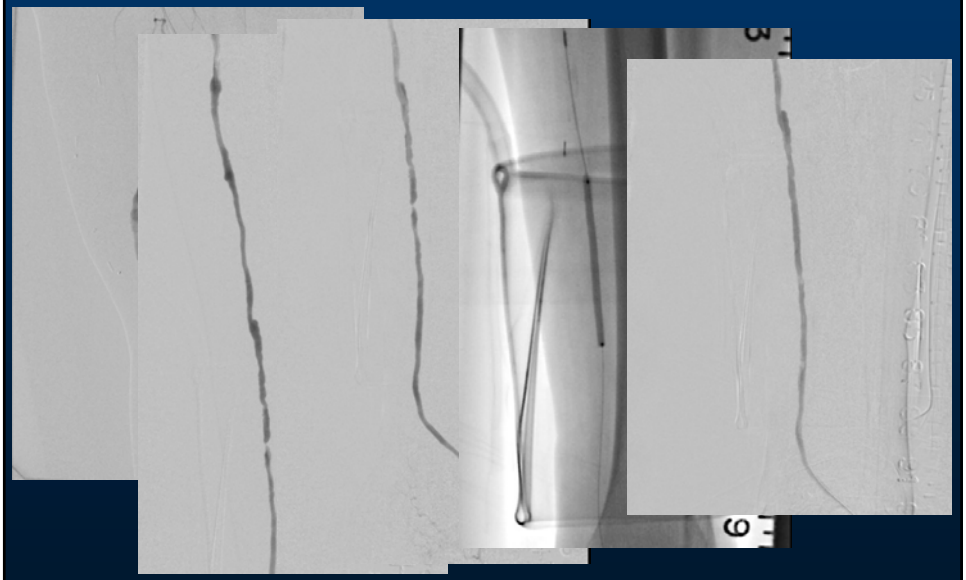
Pop-DP Bypass



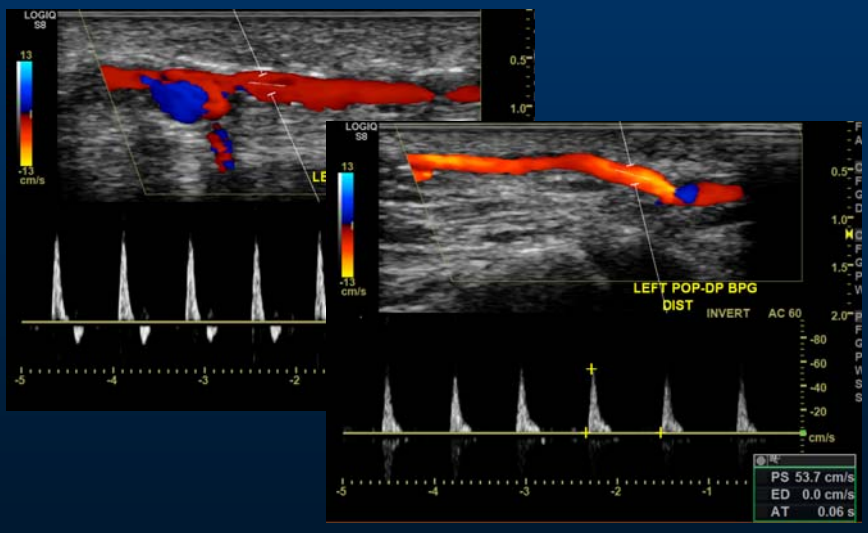
Pop-DP Bypass



Pop-DP Bypass



Pop-DP Bypass



Summary

1) Early follow-up with clinical exam, ABI and DUS to establish baseline for infrainguinal vein graft surveillance
2) Follow at 3, 6, 9, 12 months and yearly after
3) More frequent for uncorrected abnormalities or compromised conduit
4) DUS is optional after PTFE bypass and surveillance should be every 6 – 12 months if no new symptoms