Duplex Ultrasound Follow-up After Interventions:
When, How Often, What To Look For

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250-300 PM

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Disclosures

- None relevant
- Consultant and speaker
  - Medtronic
- Speaker:
  - Cook, Medtronic and Penumbra
- Grant
  - SIR Foundation

Post procedure ultrasound

- Superficial Procedures
  - Endovenous ablation
- Deep vein procedures
  - Iliac vein and IVC stenting

After varicose vein treatment

- Reasons
  - Late after a procedure
    - Evaluate for persistent or recurrent symptoms
  - Early after procedure
    - Identify thrombotic complications
    - Assess success of ablation

DUS After ablation

- Impact on care is very low
  - High success rate of ablation
  - Rare deep vein thrombus,

The 2023 Society for Vascular Surgery, American Venous Forum, and American Vein and Lymphatic Society clinical practice guidelines for the management of varicose veins of the lower extremities. Part II
Endorsed by the Society of Interventional Radiology and the Society for Vascular Medicine
Gloviczki P, et al. J Vasc Surg Venous Lymphat Disord. 2023

11. Management of ablation-related thrombus extension (ARTE) and deep vein thrombosis (DVT) after endovenous ablations		
11.1. Postprocedure duplex ultrasound scanning (DUS)		
Guideline	Grade of recommendation	Quality of Evidence
11.1. In an average-risk patient who is asymptomatic following thermal ablation of the saphenous vein, we recommend against routine early postprocedural DUS to detect ARTE (ARTE, formerly known as endovenous heat-induced thrombosis [EHIT]) or DVT.	1 (strong)	B (moderate)

Personal: POCUS

After ablation
Symptomatic or higher risk of thrombosis

- Impact on care is higher
  - Include indication for scan in report

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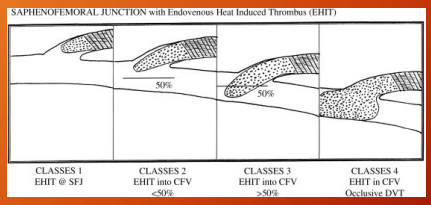
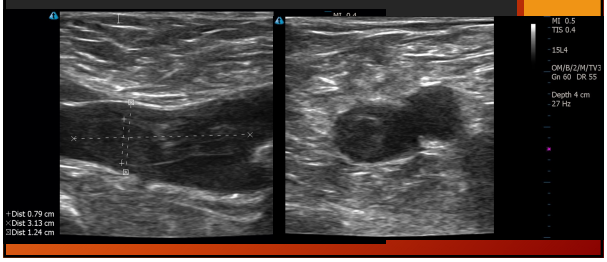
11. Management of ablation-related thrombus extension (ARTE) and deep vein thrombosis (DVT) after endovenous ablations		
11.1.3. In a high-risk patient who is asymptomatic following thermal or nonthermal saphenous ablation early DUS to exclude ARTE or DVT should be performed.		
Guideline	Grade of recommendation	Quality of Evidence
11.1.4. In patients who are symptomatic following thermal or nonthermal ablation, we recommend early DUS to exclude ARTE or DVT.	1 (strong)	A (high)



ARTE

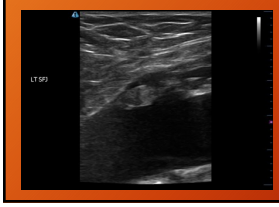
Ablation related
Thrombus extension

ARTE 3



ARTE and position

standing



Same patient, now supine
Thrombus pistons deeper into CFV

Granuloma after glue ablation

- Cyanoacrylate (Venaseal)
  - Success = thermal ablation
- Granuloma – unique complication
  - low rate of occurrence

Courtesy Dr M Gupta

Post stent evaluation

- When to do DUS?
  - No consensus
- Symptom driven approach
  - Advantage-less resource utilization
  - Disadvantage- often after stent thrombosis
- Risk based approach
  - Post thrombotic stented patients scanned routinely
- Routine post stent surveillance
  - Periodic imaging of all patients after stenting

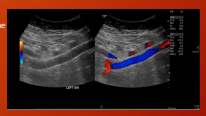
Mechanisms of stent failure

- In stent stenosis
  - Acute Thrombosis
  - Neointmal stenosis
  - Kink
  - Fracture
  - Inadequate diameter stent
- External compression
  - Unique to venous stents
  - At points of compression
    - Left common iliac vein
- Inflow/outflow native vein pathology
  - Post thrombotic narrowing
    - Inadequate coverage by stents of all lesions
      - Common femoral and common iliac veins
  - Acute thrombosis, partially occlusive and occlusive
  - Unrecognized compression

Iliac and IVC Stenting

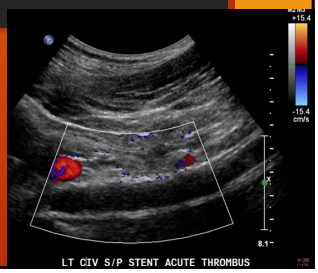
*Technique: **Imaging follow-up***

- **Standard analysis**
  - Use criteria established for native veins
- **Image the stent**
  - Define the extent, diameter, continuity, kinking
    - Look for luminal stenosis, compression
      - Include color, power Doppler and Pulse wave analysis along the
    - Image stent geometry relative to
      - other stents (fractures, discontinuities)
      - native veins (kinks)
  - Flow
    - respiratory variability in and below the stents
    - calculated flow rate my be good metric
- **Image inflow and outflow vessels**
  - Post thrombotic stent patients
    - Common femoral and common iliac



Post stent evaluation

- Patency
  - Yes, no, partial

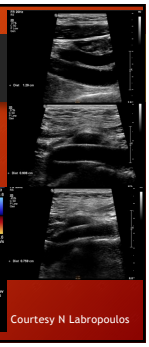


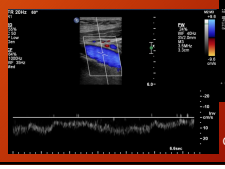
Courtesy N Labropoulos

Post stent evaluation

- Top, bottom, middle of stented segment

- **Direct:**
  - **Diameter stenosis**
  - **Luminal changes**
  - **Peak flow velocity ratio**
- **Indirect**
  - **Flow pattern analysis**
    - **Phasic vs not**
    - **Comparison with other side**
    - **Augmented or not**
    - **IIV flow direction**
    - **Flow direct of epigastric vein**





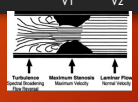
Courtesy N Labropoulos

Diffuse luminal narrowing

Courtesy N Labropoulos

In stent narrowing

thrombus, hyperplasia of the neo-intima or both

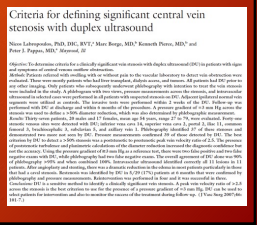


50% narrowing (diameter) postulated as significant

PWD analysis of velocities:
Velocity ratio

In stent narrowing

thrombus, hyperplasia of the neo-intima or both



Criteria for defining significant central vein stenosis with duplex ultrasound

PWD analysis of velocities:
Velocity ratio 2.5 - V1/V2

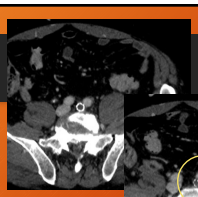
> 50% narrowing

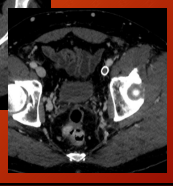
Reasons for stent failure

- Kink
  - In stent
  - Above or below
    - Stents rigid and straighten
      - Veins curved

Stent fracture and movement

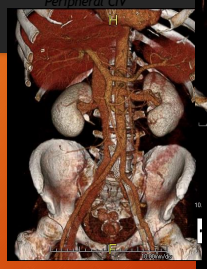
At point of maximal curvature
At a vertebral body osteophyte

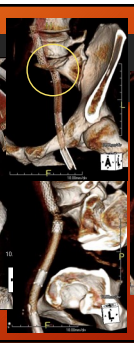


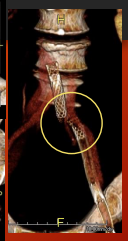


Courtesy of Rusty Hoffman

Peripheral CIV

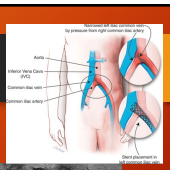


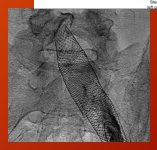




Reasons for stent failure

- Stent inadequately covers the lesion
  - Left common iliac vein compression by iliac artery

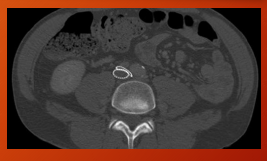




Contralateral iliac vein thrombosis

Stent extension into IVC restricts flow from other iliac vein

Stenting the IVC confluence



de Gitaf Cardiovasc Intervent Radiol DOI 10.1007/s00270-015-1068-5

Post stent evaluation

- Indirect methods
  - Incomplete visualization
  - Functional assessment of direct findings

In-stent stenosis indirectly identified

- Sebastian. European Journal
- of Vascular and Endovascular
- Surgery, 2020

Table3. Performance of categorical duplex ultrasound parameters for detecting >50% upstream venous stent obstruction in case–control cohort. Patients with confirmed venous stent obstruction (VSO group, cases, *n*=40) were matched to patients without VSO (control group, n=80). Sensitivity and specificity of categorical duplex parameters were calculated to diagnose or rule out >50% VSO

Parameter	Sensitivity (95% CI) — %	Specificity (95% CI) — %
Peak flow velocity at stent inlet ≤10cm/s at follow up	71.8 (56.2–83.5)	98.7 (93.3–99.8)
Any Doppler flow pattern other than spontaneously modulated by respiration at stent inlet	84.6 (70.3–92.8)	94.9 (87.7–98.0)
Monophasic Doppler pattern or no flow at stent inlet	53.8 (38.9–68.4)	100 (95.4–100)
Pattern change at stent inlet from baseline to follow up	81.0 (64.7–91.1)	95.0 (87.8–98.0)
Decrease in peak flow velocity at stent inlet ≥50% from baseline to follow up	74.2 (56.8–86.3)	82.0 (72.4–89.1)

Data are given as % with the 95% confidence interval (CI).

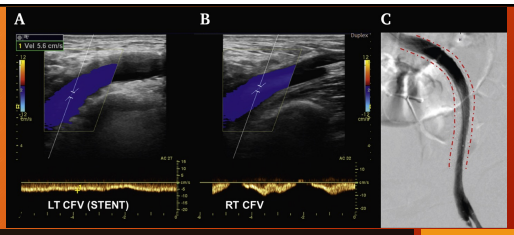
Table 2. **Diagnostic performance of continuous duplex ultrasound parameters for detecting >50% upstream venous stent obstruction in case–control cohort of patients with confirmed venous stent obstruction (VSO group, cases, n = 40) matched to patients without VSO (control group, n = 80). Sensitivity and specificity of continuous duplex parameters were calculated to diagnose or rule out >50% VSO**

Parameter	VSO group (n = 40)	Control group (n = 80)	AUC (95% CI)	Cut-off* — cm/s	Sensitivity (95% CI) — %	Specificity (95% CI) — %
Peak flow velocities — cm/sec						
Common femoral vein	9.6 ± 12.3 7.0 (0.0, 12.0)	25.9 ± 13.0 20.0 (20.0, 30.0)	0.88 (0.79–0.97)	14.0	81.1 (65.8–90.5)	91.3 (83.0–95.7)
Stent inlet	10.9 ± 9.5 10.0 (5.0, 12.0)	25.9 ± 13.9 20.0 (20.0, 33.8)	0.90 (0.83–0.97)	14.5	84.6 (70.3–92.8)	88.8 (80.0–94.0)
Indices						
Femoral index†	0.43 ± 0.35 0.29 (0.00, 0.76)	1.00 ± 0.41 1.00 (0.72, 1.11)	0.83 (0.71–0.94)	0.57	73.1 (53.9–86.3)	92.0 (83.6–96.3)
Stent inlet PFV baseline to follow-up ratio‡	0.40 ± 0.36 0.33 (0.19, 0.50)	1.09 ± 0.57 1.00 (0.65,1.47)	0.88 (0.80–0.96)	0.48	74.2 (56.8–86.3)	89.9 (81.2–94.8)

Data are given as mean ± standard deviation and median (interquartile range) unless stated otherwise. AUC = area under the curve; CI = confidence interval; PFV = peak flow velocity.
* Cut-off values from the receiver operating characteristics analysis based on the highest Youden (*J*) index.
† Venous femoral velocity index = ratio of ipsilateral PFV divided by contralateral PFV, measured at the common femoral vein.
‡ Stent inlet PFV baseline to follow-up ratio = ratio of ipsilateral peak flow velocity at follow up divided by baseline measurement, obtained at stent inlet.

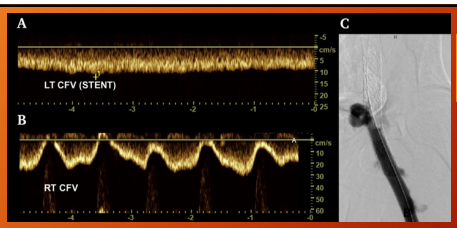
In-stent stenosis indirectly identified

Sebastian. European Journal of Vascular and Endovascular Surgery, 2020



In-stent stenosis indirectly identified

Sebastian. European Journal of Vascular and Endovascular Surgery, 2020



Stent occlusion indirectly identified

Sebastian. European Journal of Vascular and Endovascular Surgery, 2020

Conclusions

AFTER ABLATION
- Eliminate routine post ablation complete DUS
- Save post ablation DUS for
  - Post procedure symptoms
  - High risk for thrombosis patients

AFTER STENTING
- Consider surveillance on stents placed for thrombosis
  - Get baseline scans early for later comparison
  - Evaluate the entire stent and stented segment
  - Use of indirect metrics assess functionality
  - Symptomatic patients after non-thrombotic stenting