

Duplex sonography for the detection of venous stent obstruction

A case control study

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Disclosure

Speaker name:

Tim Sebastian.....

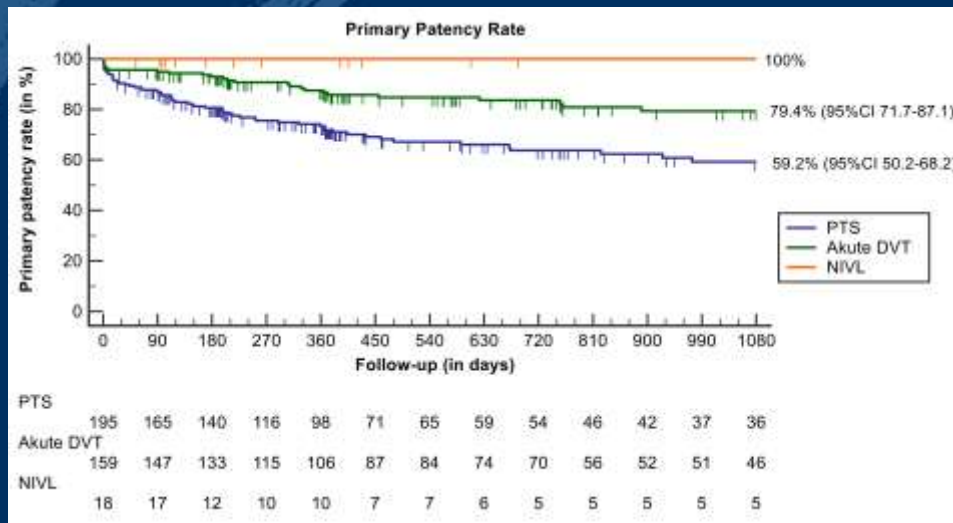
I have the following potential conflicts of interest to report:

- Consulting
- Employment in industry
- Stockholder of a healthcare company
- Owner of a healthcare company
- Other(s)

- I do not have any potential conflict of interest

Background

- Duplex ultrasound is the first-line examination tool for routine stent surveillance
- No validated criteria exists to detect stent obstruction (stenosis or occlusion)
- Stent patency loss remains a hazard over time



from the Swiss Venous Stent Registry
an analysis by Suvetha Gnanapiragasam



Duplex characteristics

B-mode (brightness)	C-mode (color)	PW-mode (pulsed wave)
Direct evaluation		Direct + indirect evaluation
Visualization of thrombi, in-stent deposits, planimetries (collapsed stents), collaterals	Presence or absence flow	
-	Screening for slow / fast flow	Exact measurements of flow velocities (in cm/s)
-	-	Flow pattern analysis: Flow modulated by respiration or cardiac cycle

Criteria for iliac obstruction (without stents) have been previously described in literature

Direct criteria

Planimetric diameter stenosis

Luminal changes

Filling (color) defects

Post-stenotic to pre-stenotic vein velocity ratio (> 2.5)

Indirect criteria

Non-phasic flow in common femoral vein

Asymmetric flow pattern in common femoral vein

Presence of collateral veins

Difficulty compressing the common femoral vein

Reversed flow in internal iliac vein

The ideal examination



Patient information

Young women

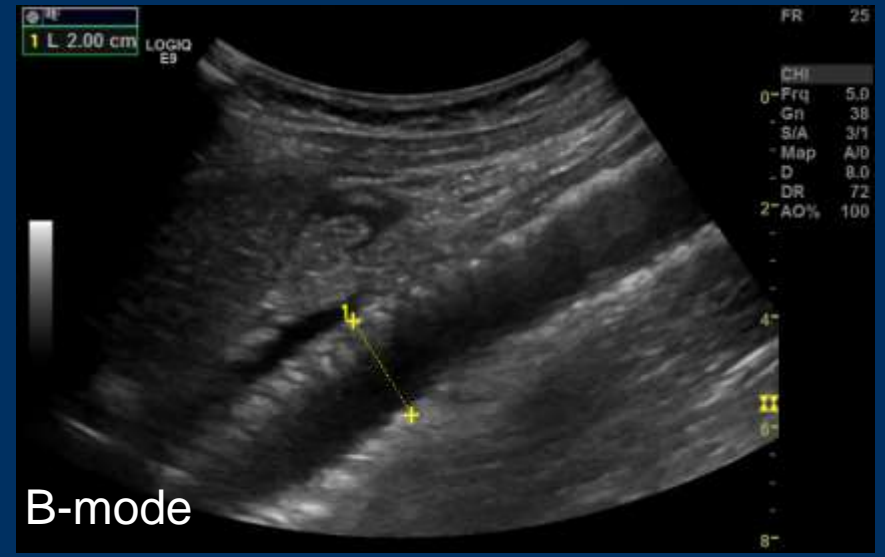
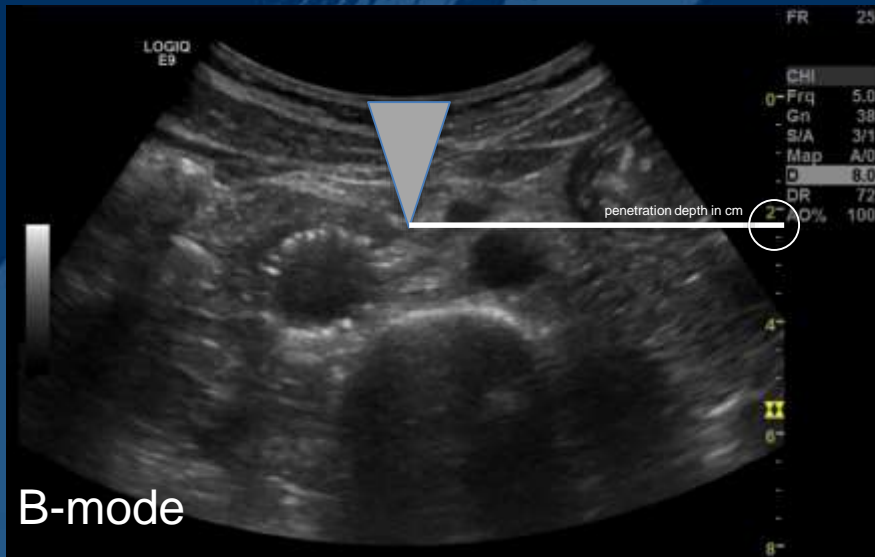
Slim

Overnight fast (stomach empty)

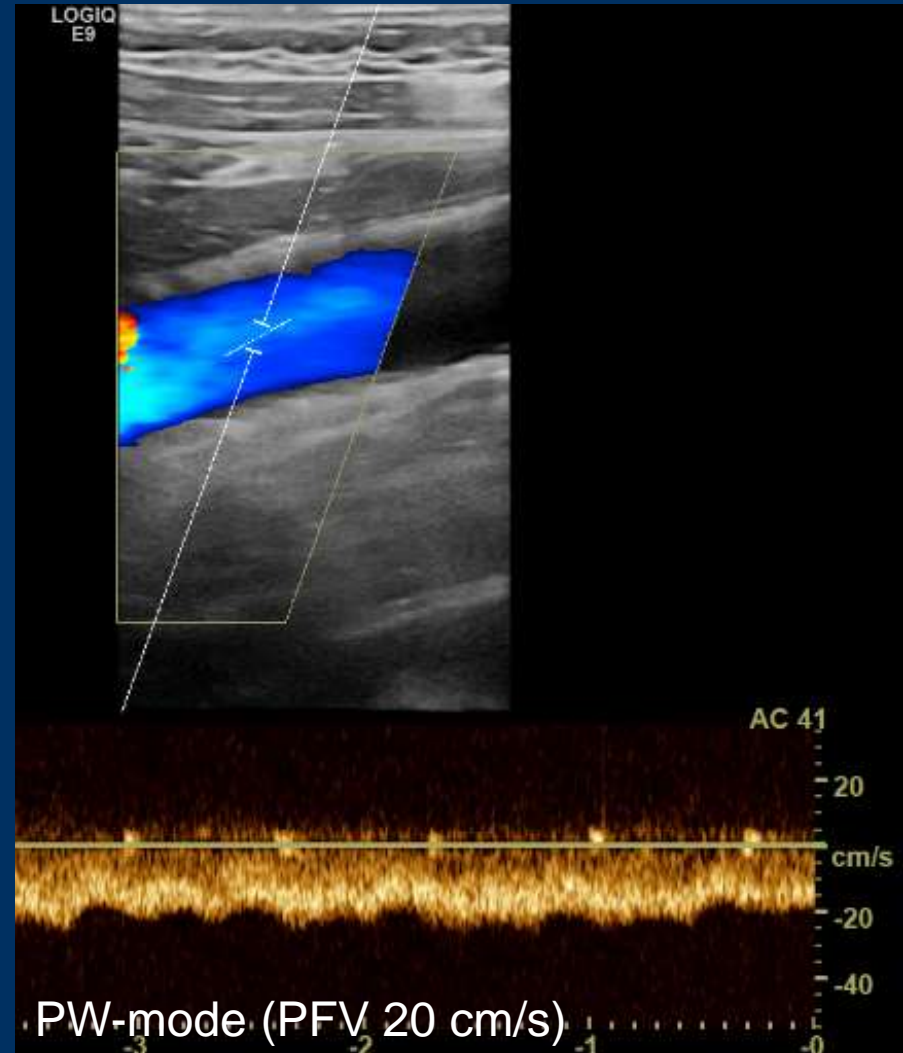
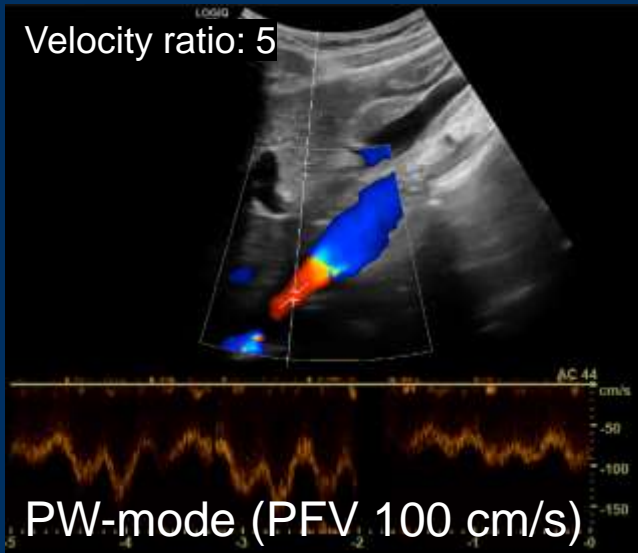
Follow-up ultrasound after IVC and iliac vein reconstruction (PTS)

Residual leg symptoms including venous claudication and dyspnea when exercising

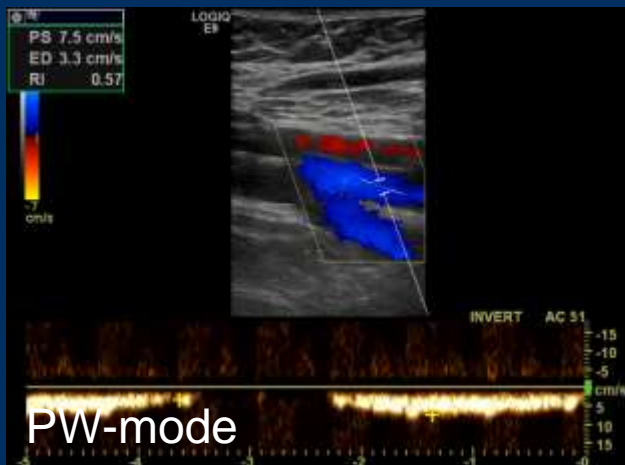
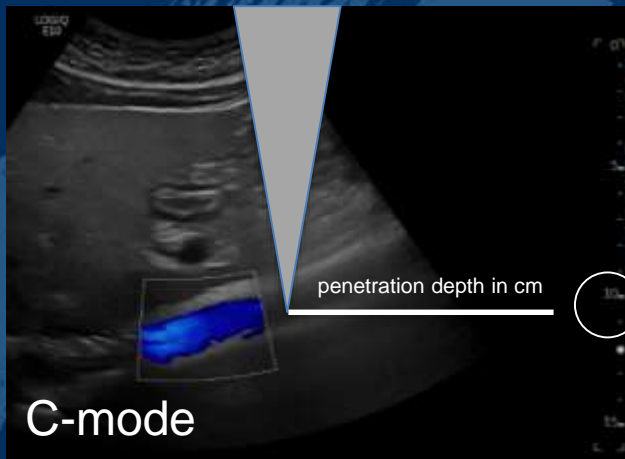
The ideal examination



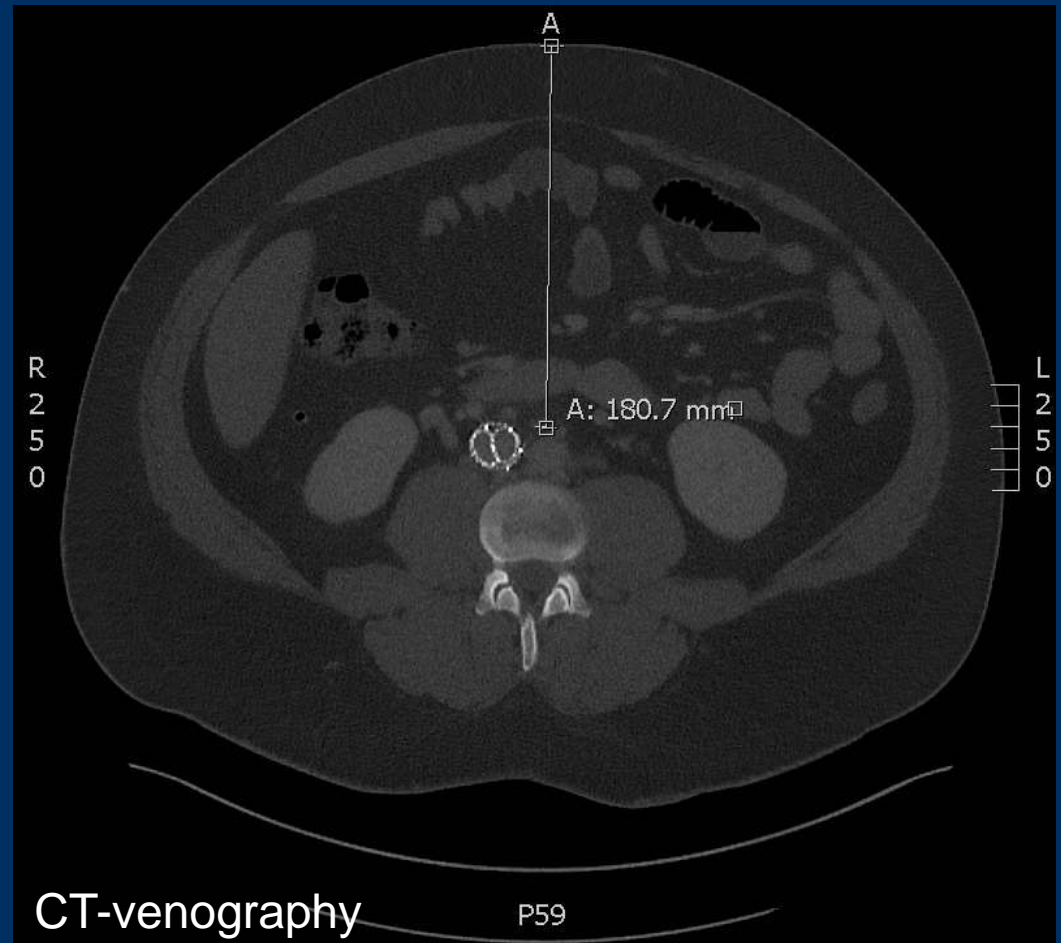
The ideal examination



Limitation of duplex sonography



Sometimes only the femoral veins are accessible



Criteria for iliac obstruction (without stents) proposed in literature

Direct criteria

Planimetric diameter stenosis

Luminal changes

Filling (color) defects

Post-stenotic to pre-stenotic
vein velocity ratio (> 2.5)

Indirect criteria

Non-phasic flow in common femoral vein

Asymmetric flow pattern in common
femoral vein

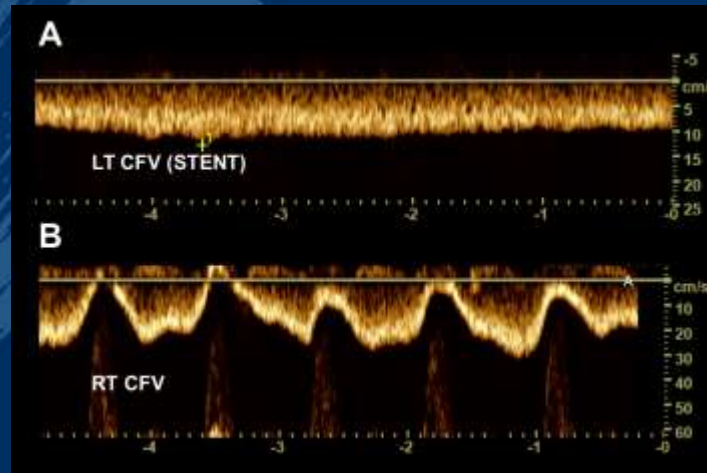
Presence of collateral veins

Difficulty compressing the common femoral
vein

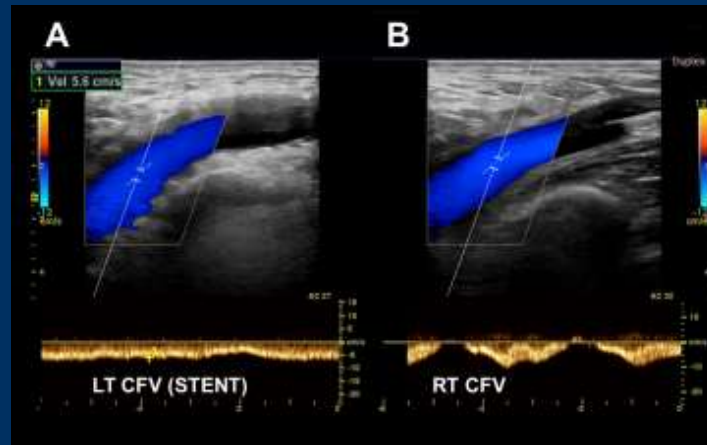
Reversed flow in internal iliac vein

What if this is all you have?

Patient 1

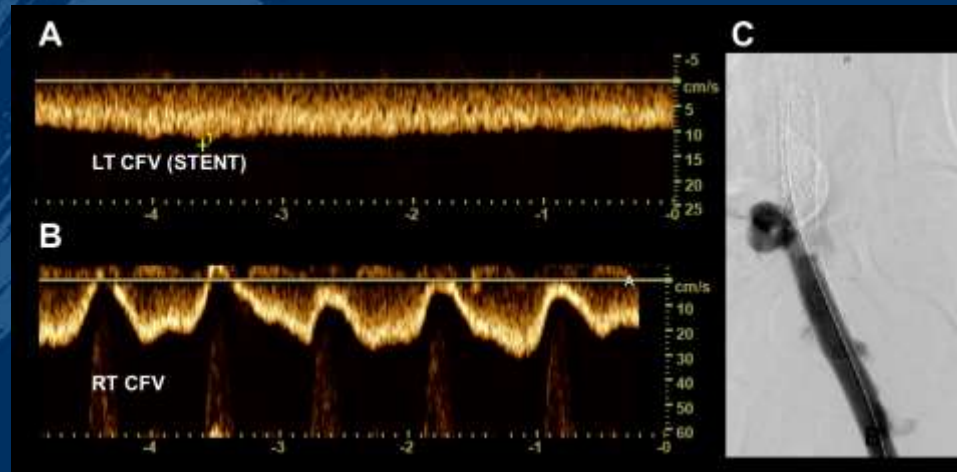


Patient 2

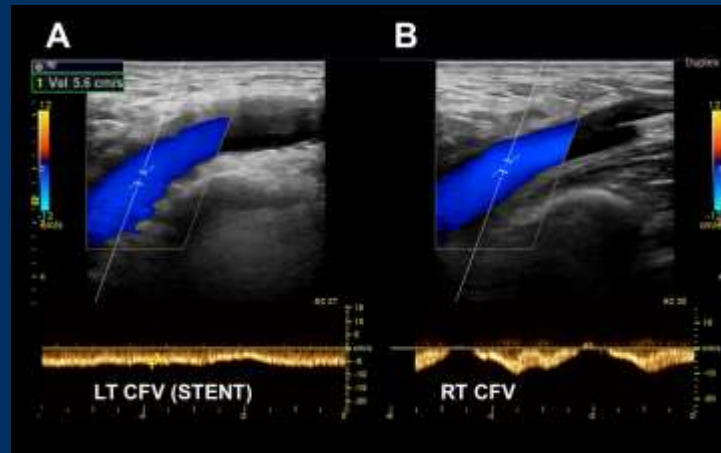


What if this is all you have?

Patient 1

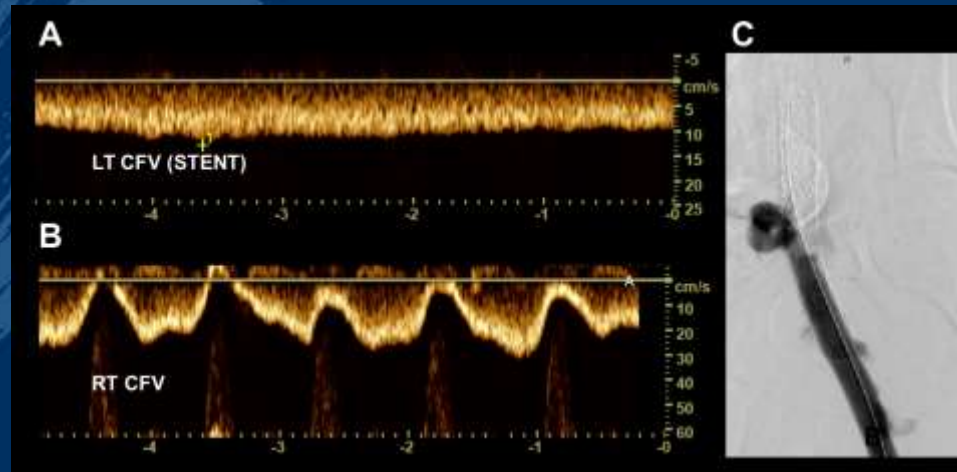


Patient 2

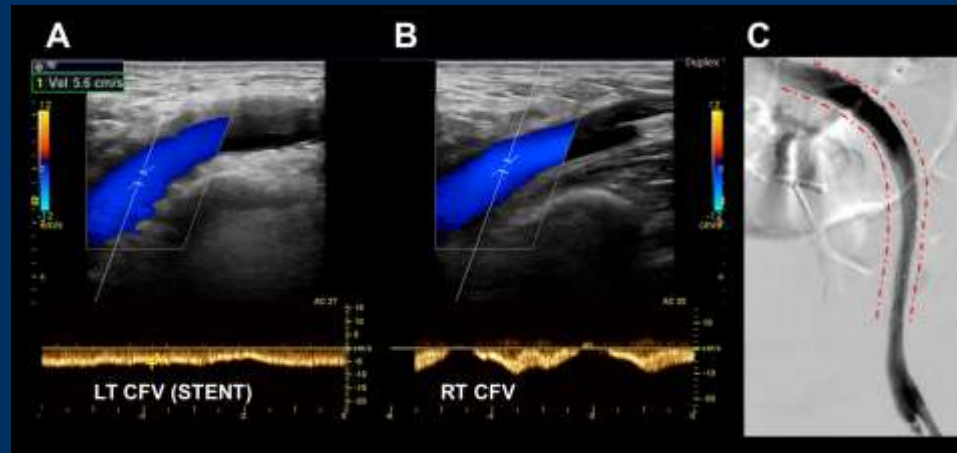


What if this is all you have?

Patient 1



Patient 2



Swiss Venous Stent Registry

- Includes baseline, procedural and follow-up data of >400 patients with venous stents and follow-ups up to 5 years including duplex ultrasound exams.
- Nested case-control study (120 patients)
- Cases (25 stent occlusion, 15 stent stenosis >50%)
 - Venous stent obstruction (>50%) diagnosed in venography (re-intervention)
 - Available duplex ultrasound exams prior to re-intervention.
- Controls (2:1):
 - Matched by age (± 10 years), sex and index diagnosis
 - Criteria: ongoing symptom control, good imaging quality (review of stored images, reports), spontaneous color signal >50% of lumen in entire stent, availability of at least two ultrasound exams. No venographic images!

Baseline

	Overall (120)	Venous stent obstruction (40)	Control (80)
Demographics			
Age, years	41.8 ± 17.2	42.5 ± 18.0	41.4 ± 16.8
Female	63 (53)	21 (53)	42 (53)
Index event			
Postthrombotic syndrome	93 (78)	31 (78)	62 (78)
Acute deep vein thrombosis	21 (18)	7 (18)	14 (18)
Tumor provoked venous obstruction	6 (5)	2 (5)	4 (5)
Procedural			
Mean number of stents implanted	2.7 ± 1.8	2.9 ± 2.1	2.6 ± 1.7
IVC reconstruction	33 (28)	9 (23)	24 (30)
Stent below the inguinal ligament	63 (53)	24 (60)	39 (49)

Continuous duplex parameters

	Cases (40)	Controls (80)	AUC (95% CI)	Cut-off, cm/s	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)
Peak flow velocities (in cm/s)						
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 ± 13.0 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 ± 0.55 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 (0.60;1.47)	0.88 (0.80-0.96)	0.48	74.2 (56.8-86.3)	89.9 (81.3-94.8)
Venous femoral velocity index, ratio of ipsilateral peak flow velocity divided by contralateral peak flow velocity						
Stent inlet PFV baseline to follow-up ratio, ratio of ipsilateral peak flow velocity at follow-up divided by baseline measurement						

Categorical duplex parameters

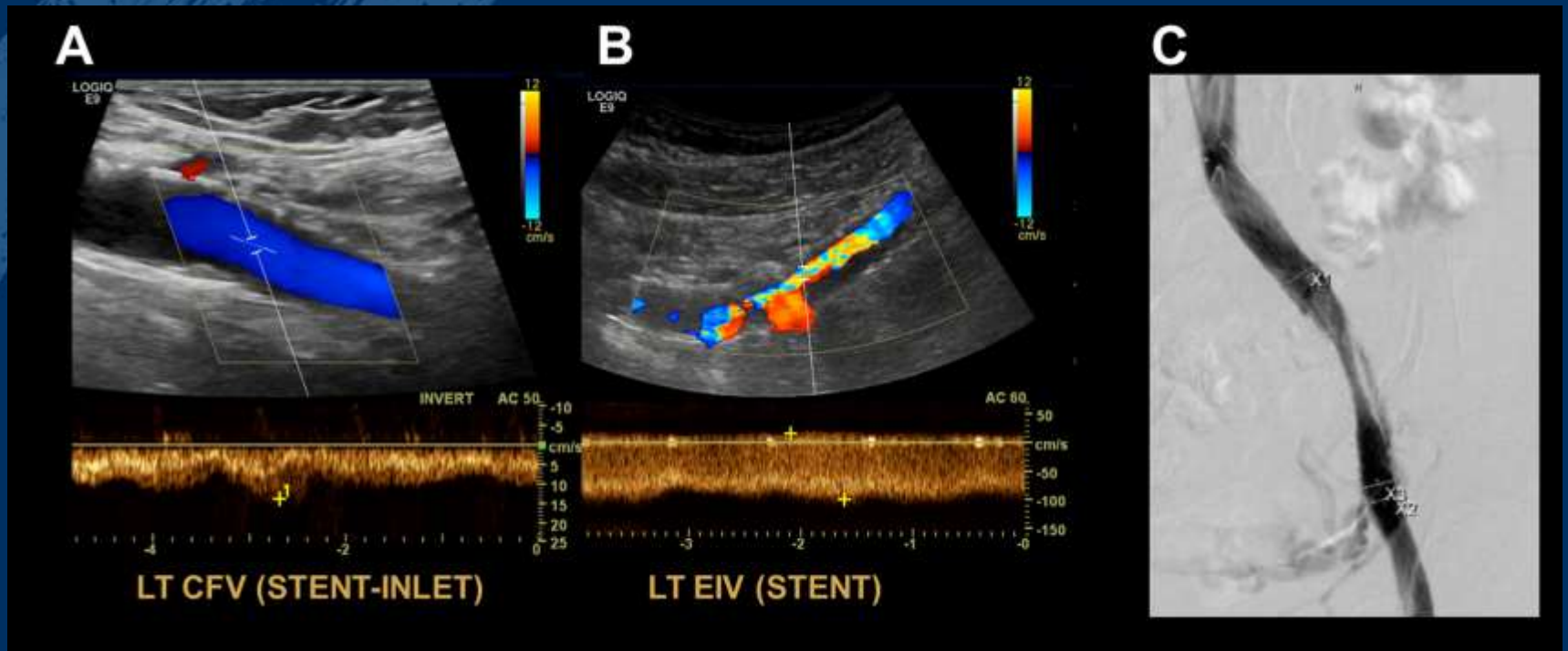
	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)
Any Doppler flow pattern other than spontaneously modulated by respiration at stent inlet	84.6 (70.3-92.8)	94.9 (87.7-98.0)
Monophasic Doppler pattern or no flow at stent inlet	53.8 (38.9-68.4)	100 (95.4-100)
Pattern change at stent inlet from baseline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

Main findings

Peak flow velocity >10 cm/s **AND** flow pattern spontaneously modulated by respiration ruled out $>50\%$ upstream venous stent obstruction with a **specificity** of **93.7%** (95%CI 86.0-97.3%).

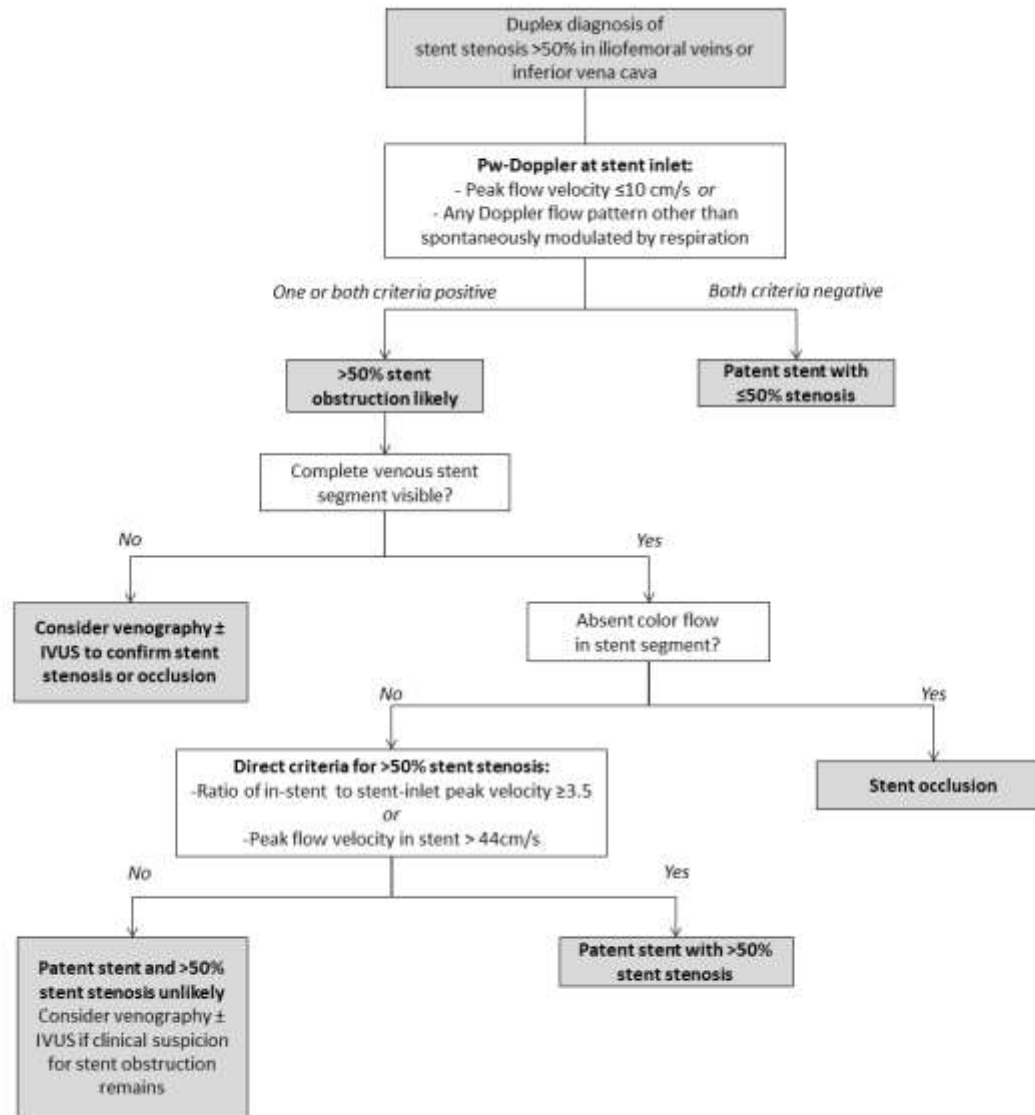
Peak flow velocity ≤ 10 cm/s **OR** any Doppler flow pattern other than spontaneously modulated by respiration was **92.1%** (95%CI 79.2-97.3%) **sensitive** to detect upstream venous stent obstruction.

Indirect criteria for venous stent stenosis were less sensitive than for stent occlusion (but still specific)



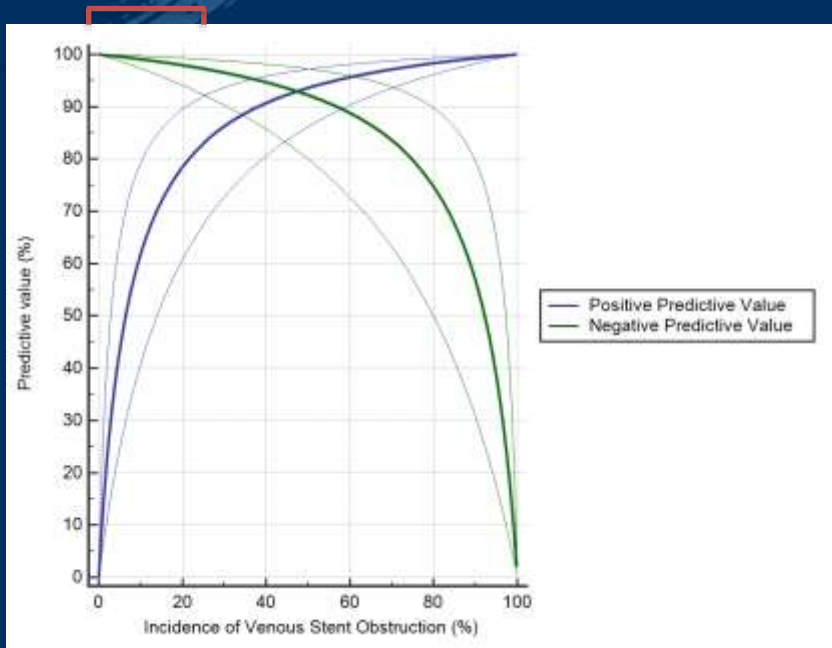
Direct visualization should always be performed as gold standard for all patients!

Proposed diagnostic algorithm



Limitations

- Retrospective study design, rather small cohort
- Many duplex investigators and different machines
- Matched controls had no venography (but strict inclusion criteria applied)



Limitation of case-control studies

Predictive values depend on incidence, and incidence is determined by the ratio of cases to controls (here 1:2)

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