Management of chronic deep vein obstruction

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Diagnostic tools for DVT – systemic suspicion

- Probability of DVT: Rotterdam DVT score

Clinical feature	Score
Active cancer treatment ongoing or within previous 6 months or palliative	1
Paralysis, paresis, or recent plaster immobilization of the lower leg(s)	1
Recent immobilization for more than 3 days or major surgery within last 4 weeks	1
Localized tenderness/pain along the distribution of the deep venous system	1
Entire leg swollen	1
Calf swelling by more than 2 cm when compared with the asymptomatic leg (measured 10 cm below tibial tuberosity)	1
Pitting oedema more pronounced in the symptomatic leg	1
Collateral superficial veins (nonvaricose)	1
Total Rotterdam DVT score	**8**
Score 0 (asymptomatic)=low, score 1 or 2=moderate, score 3 or more=high	

- Differential diagnosis
  - Baker's cyst (ruptured)
  - Plantaris tendon tearing
  - hematoma
  - Muscle tears or pulls
  - Cutaneous infection
  - Lymphedema
  - Venous reflux
  - PAoD

Diagnostic tools for DVT – imaging

- Invasive venography
  - Gold standard
    - Negative venography: NPV 98.1~99%
    - Invasiveness
      - limited use as a routine test for DVT diagnosis and exclusion
      - Replaced by compression ultrasonograpy (CUS)
- Complete Compression US (CCUS)
  - Advantage
    - Noninvasive, relatively low cost, no time consuming
  - Disadvantage
    - Isolated iliac vein thrombus
    - Adductor foraminal area venous thrombus
- D-dimer
  - Non-specificity: malignancy, infection, inflammation, pregnancy

Diagnostic flows

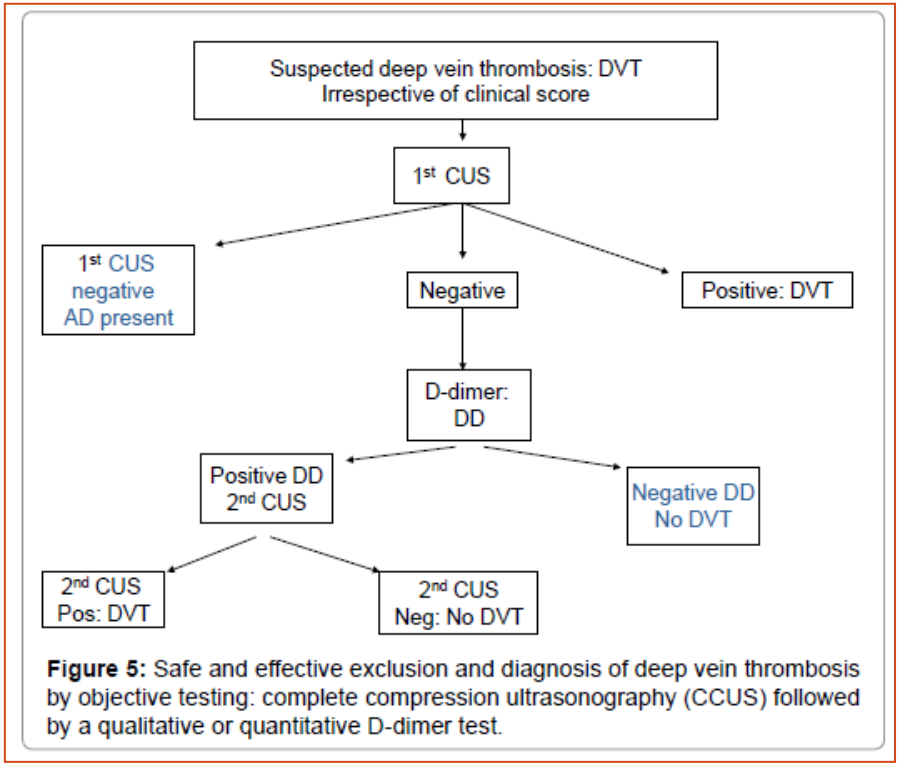
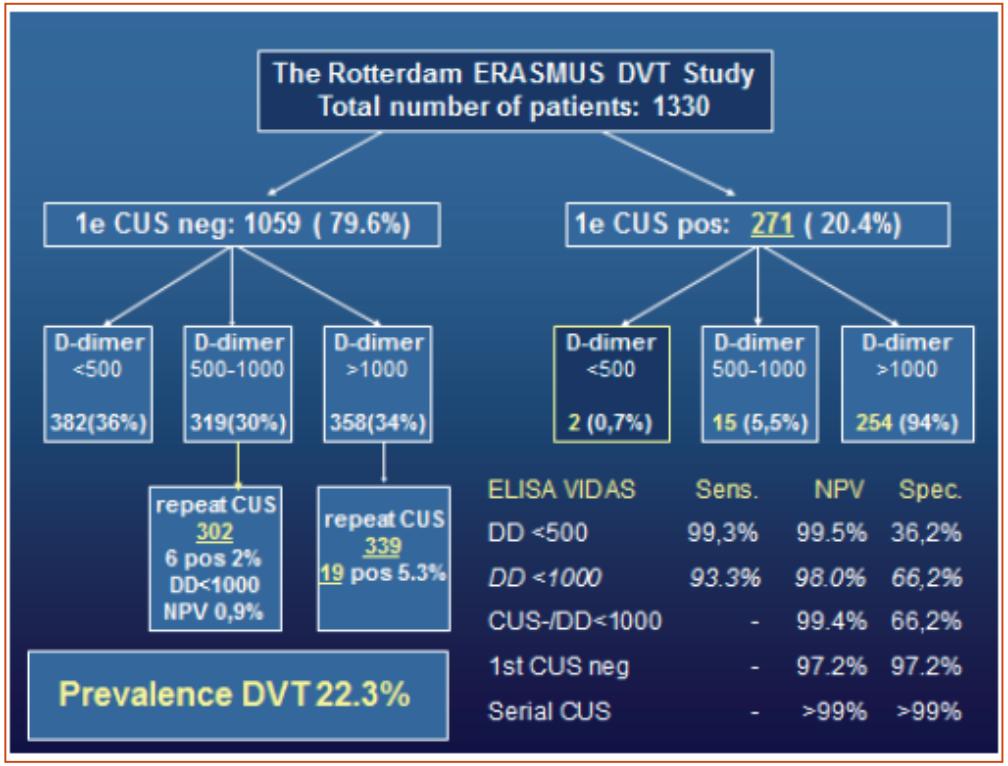


Figure 5: Safe and effective exclusion and diagnosis of deep vein thrombosis by objective testing: complete compression ultrasonography (CCUS) followed by a qualitative or quantitative D-dimer test.



Int Angiol. 2004;24:27-39, Ann Intern Med. 2002;162:907-11.

Usual treatment of DVT

- Therapeutic goals of DVT
  - Prevent clot propagation
  - Prevent PTE
  - Avoidance of recurrent thrombosis
  - Reduction the risk of postthrombotic morbidity
    - Prevention for chronic deep vein obstruction

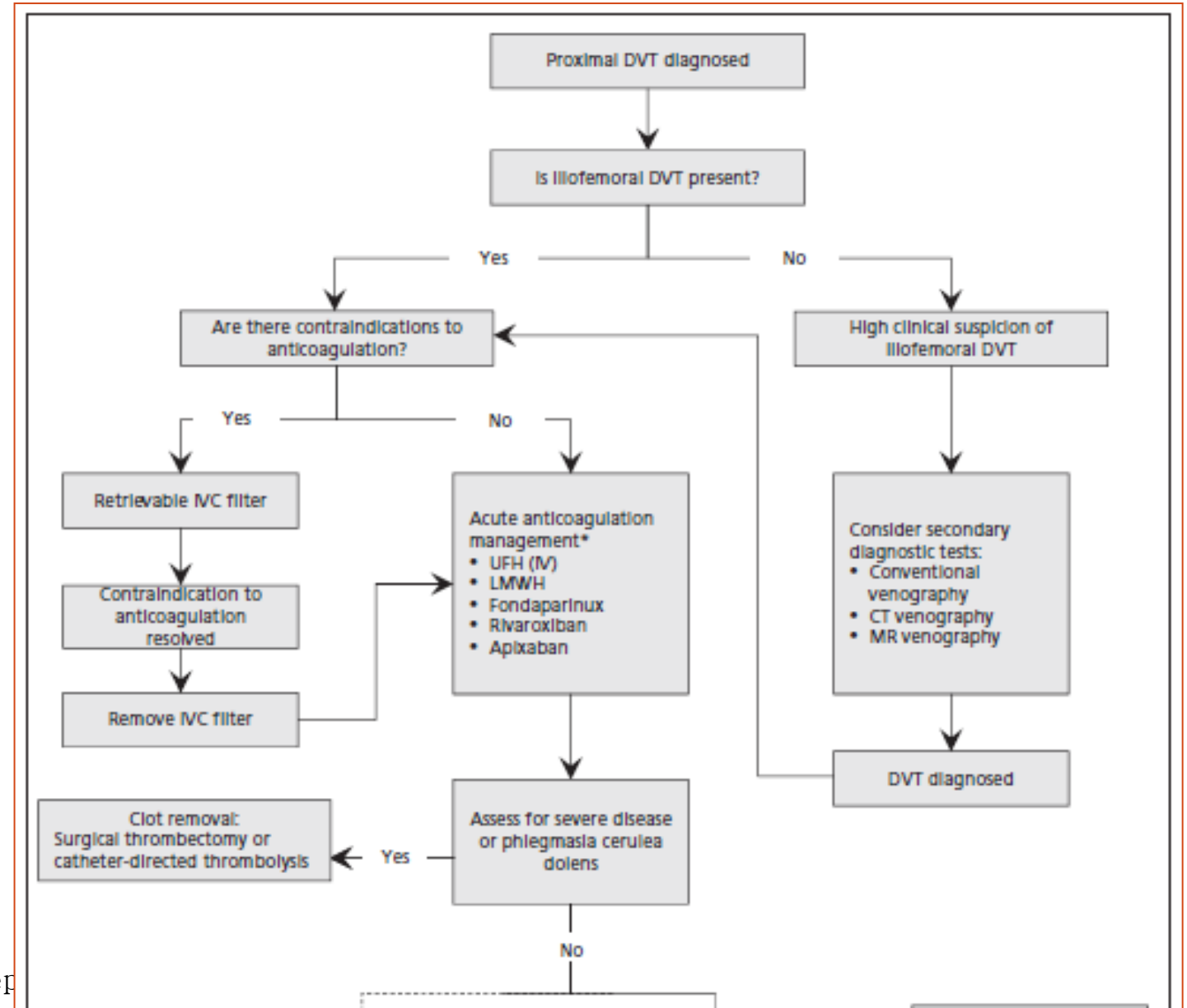
Phlebology. 2015;30L59-66.

Usual treatment of DVT

- Adequate anticoagulation
  - LMWH or heparin start, ASAP
  - Oral anticoagulation
    - VKA, OAC for 6 months usually (idiopathic DVT)
    - Lifelong anticoagulation for specific life long risk
  - Ambulatory compression therapy or medical elastic stocking (MECS)
    - Edema resolved with ACT or MECS: class II MECS (23~32 mmHg) for 2 years more
    - Edema present with ACT or MECS: class III MECS (34~346 mmHg)
  - Vena cava filter
    - Effective in short term incidence of PE in proximal DVT
    - Do not affect mortality

BMJ. 2006;1332:215-9, Semin Thromb Hemost. 2006;32:814-

Usual treatment of proximal DVT



CMAJ 2015;Sep

Follow up of DVT

- Systematic approach to prevent and check up of PTS
  - 1, 3, 6 months and annual clinical check up and CUS, annual PTS-CEAP scoring

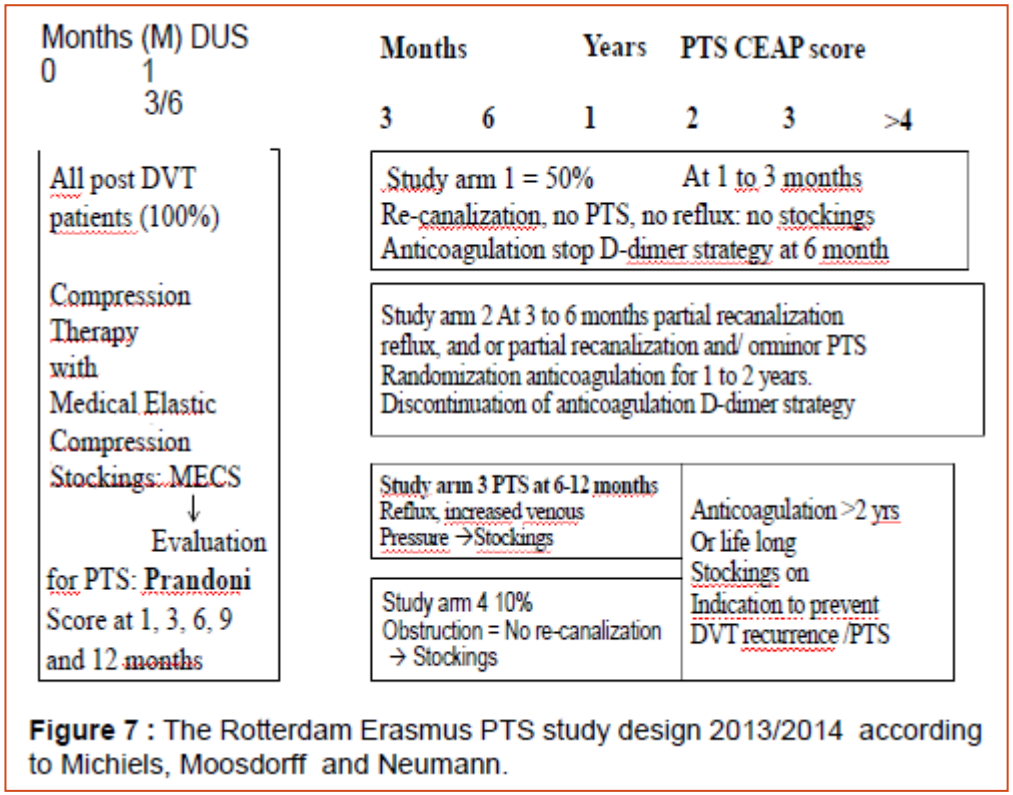
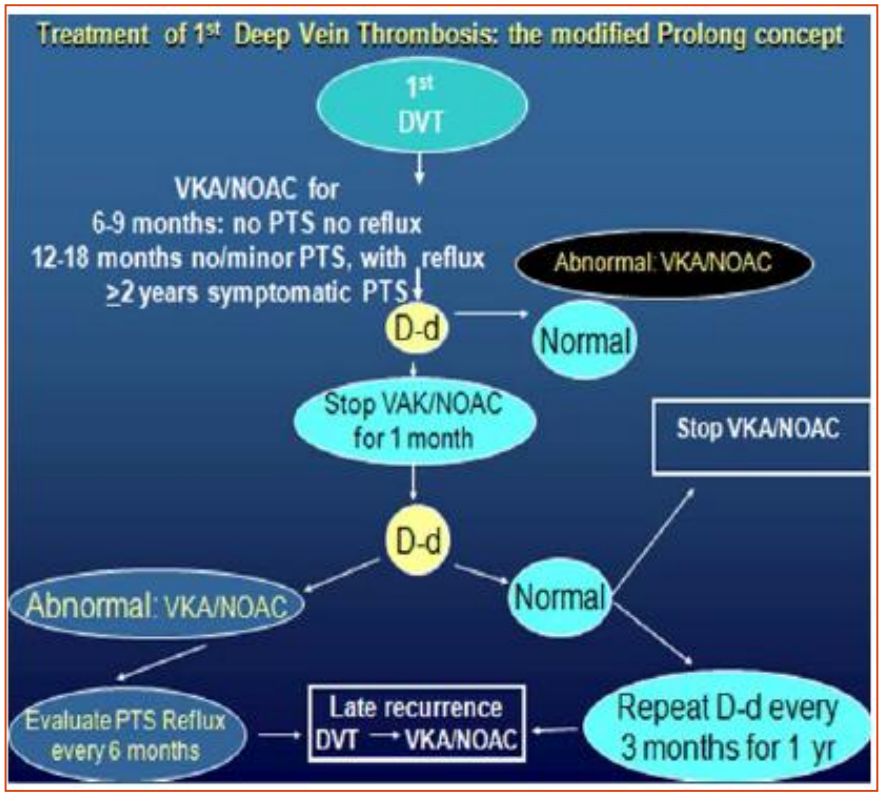


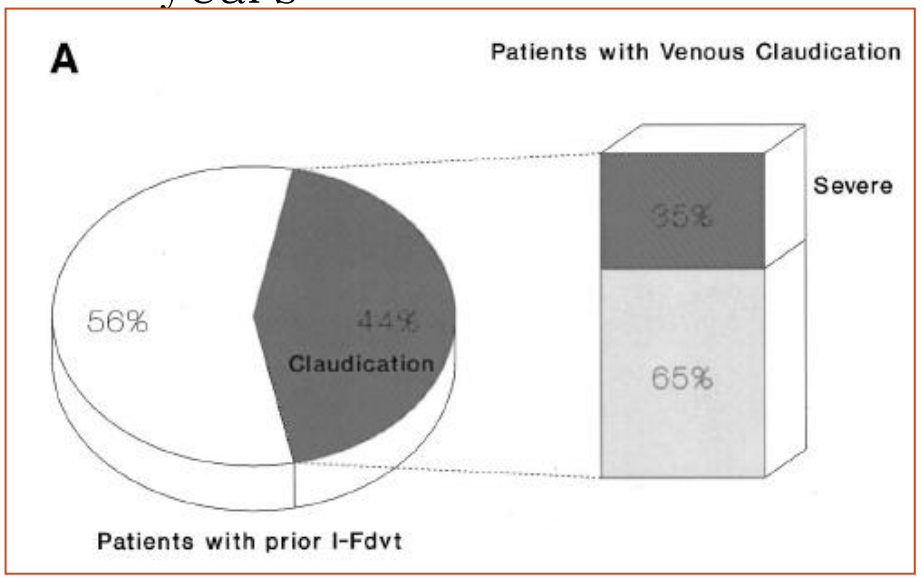
Figure 7 : The Rotterdam Erasmus PTS study design 2013/2014 according to Michiels, Moosdorff and Neumann.

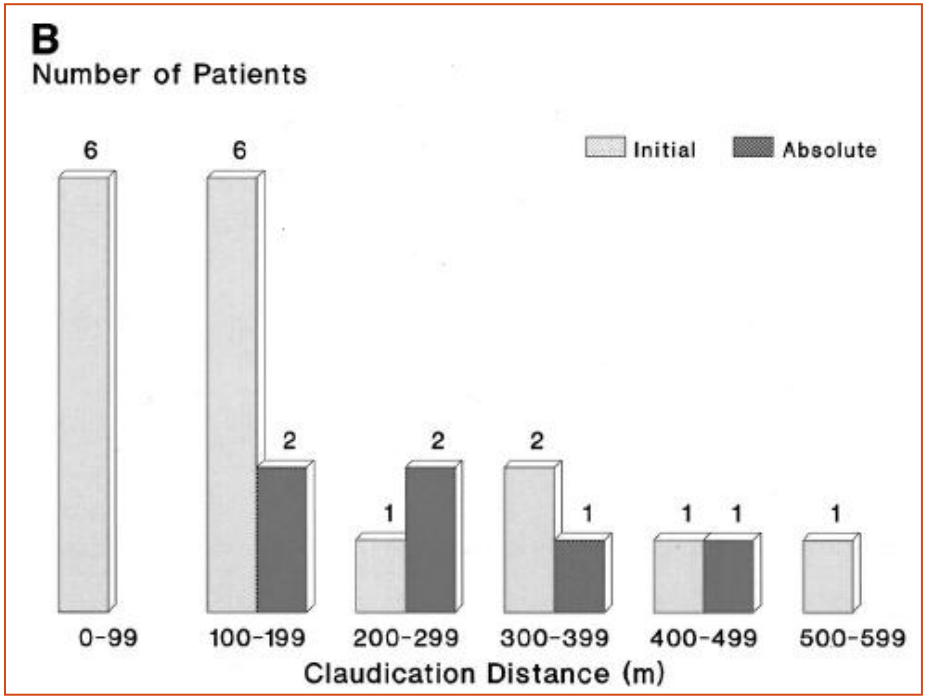


Int Angiol 2014;33:1-19

Fate of DVT – chronicity

- Fate of iliofemoral DVT (IF-DVT) treated with only anticoagulation
  - Half of these patients suffered venous claudication in 5-10 years





Ann Surg. 2004;239:118-26

Fate of DVT – chronicity

- Determinant for PTS after DVT
  - High Villalta score at 1 month after DVT throughout 24 months of follow up
  - IF-DVT compared to calf VT (HR, 2.23)
  - Higher BMI (HR, 0.14 step up in per Kg/m2)
  - Previous ipsilateral VT (HR, 1.78)
  - Older age (HR, 0.30 step up in per 10 year age)
  - Female sex

Ann Intern Med. 2008;149:698-707.

Chronic deep vein obstruction

- Definition
  - Blockage of the outflow of blood from the lower extremity, chronically
    - 3 ~ 6 months after acute DVT episode
  - Venous circulation
    - Low pressure/velocity, large volume, low resistance converging vascular system
    - Increased venous pressure: functions of
      - resistance of flow (N, location, degree of narrowing, length of lesion, collateral)
      - velocity of flow and flow volume magnitude
    - Degree of significant venous stenosis ?
      - 50% will be indication of stenting in iliofemoral lesion.
      - Due to venous peripheral vascular resistance: quite low
- Prevalence
  - Depends on poor recanalization of acute IF-DVT
    - Completer recanalization of acute iliac-DVT: 20%
    - Chronic venous insufficiency after anticoagulation alone in IF-DVT: 90% at 5 years
    - Debilitating venous claudication: 15~44%, venous ulcer: 15%

Phlebology. 2008;23:149-57.

Chronic deep vein obstruction

- Diagnosis
  - Lack of criteria for significant venous obstruction
    - No reliable test to measure a hemodynamically significant stenosis
    - Inaccurate morphological investigation
    - Clinical considering
      - Previous DVT
      - Chronic limb symptoms: pain, edema, eczema, hyperpigmentation, ulcer
    - Imaging tools
      - CUS, duplex US: especially for infrainguinal evaluation
      - CT venography, MR venography
      - invasive venography: subtraction, multiple projection/pressure injector
        - Negative collateral does not mean no stenosis.
      - IVUS: >50% stenosis – candidate for stenting
        - Trabeculation, web, venous wall thickness, neointima, external compression

Phlebology. 2008;23:149-57.

PTS; post-thrombotic syndrome

- Definition
  - Signs and symptoms that occur as long-term complications of DVT resulting from
    - Vein lumen obstruction in venous valvular incompetence.
- Incidence, prevalence of PTS
  - Annual incidence of DVT in general population
    - 1 ~ 3 of 1,000 people
  - Incidence of PTS
    - 20~50% of DVT in long-term follow-up
    - develops within a few months to a few years after symptomatic DVT
    - 5~10% of PTS: severe PTS, including venous ulcer
  - To prevent PTS
    - Improvement modalities of diagnosis and management for DVT

Circulation. 2003;107(suppl 1):I4-I8, Ann Intern Med.

Clinical Characteristics of PTS

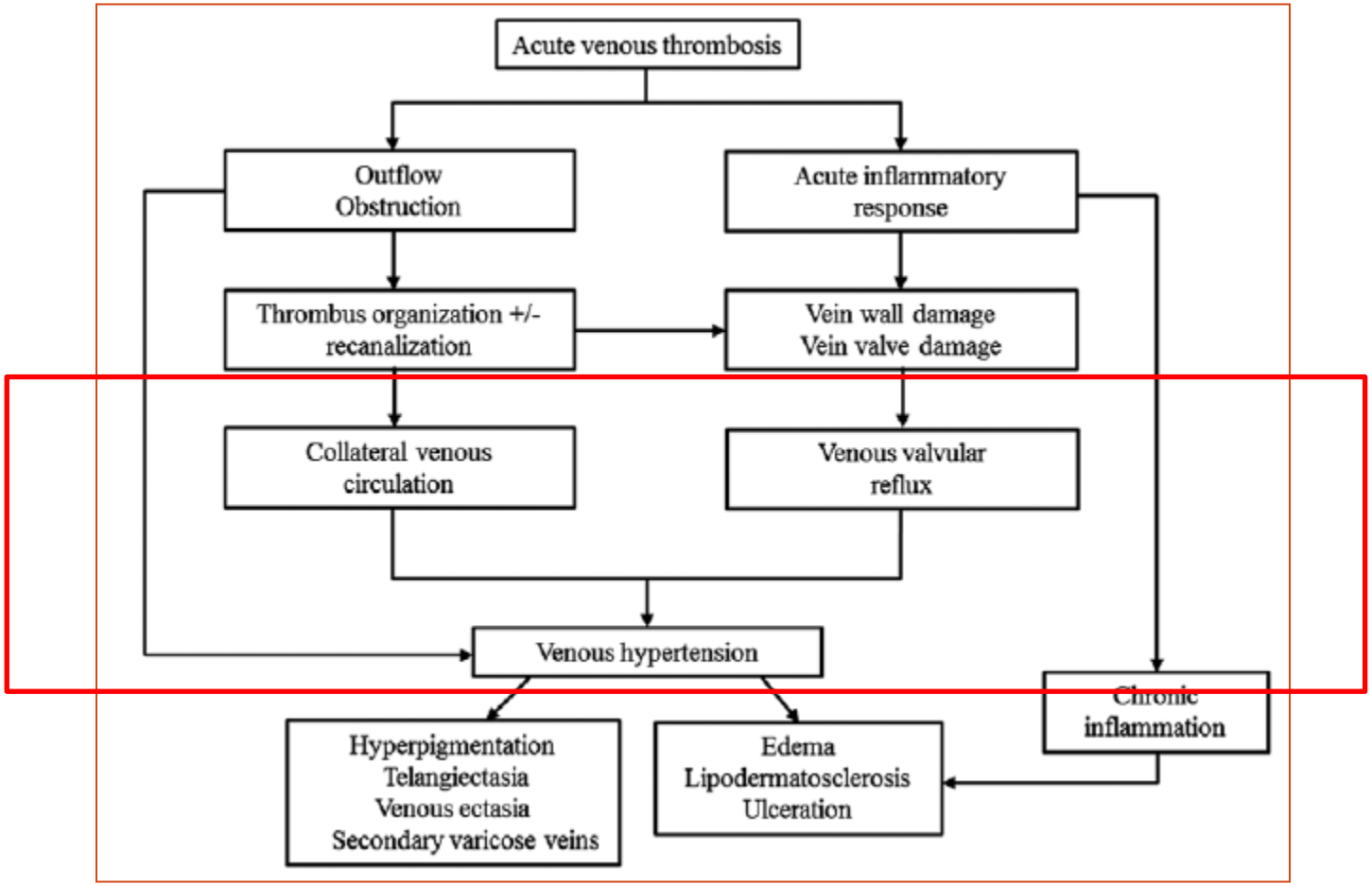
Table 2. Clinical Characteristics of PTS

Symptoms	Clinical Signs
Pain	Edema
Sensation of swelling	Telangiectasia
Cramps	Venous dilatation/ectasia
Heaviness	Varicose veins
Fatigue	Redness
Itching	Cyanosis
Pruritis	Hyperpigmentation
Paresthesia	Eczema
Bursting pain	Pain during calf compression
Venous claudication	Lipodermatosclerosis
	Atrophie blanche
	Open or healed ulcers

PTS indicates postthrombotic syndrome.

Pathophysiology of PTS

- Proposed pathophysiology of PTS



Diagnosis of PTS

- No gold standard test to diagnose PTS
- Primarily on clinical grounds with symptoms and signs
  - in patients with prior DVT
  - Wait at least 3 months for initial pain and swelling associated with acute DVT to resolve
  - Diagnosis of PTS
    - Generally deferred until after the acute phase (upto 6 months) has passed
- Clinical tools to diagnose PTS
  - After objective DVT
    - Villalta scale, Ginsberg measure, Brandjes scale
  - The others
    - CEAP classification, VCSS, Widmer scale

Villalta scale

- 5 S, 6 S, and venous ulcer in DVT affected leg
  - PTS: ≥ 5, mild, moderate and severe: 5~9, 10~14, ≥ 15 or venous ulc

	None	Mild	Moderate	Severe
5 Symptoms				
Pain	0 Points	1 Point	2 Points	3 Points
Cramps	0 Points	1 Point	2 Points	3 Points
Heaviness	0 Points	1 Point	2 Points	3 Points
Paresthesias	0 Points	1 Point	2 Points	3 Points
Pruritus	0 Points	1 Point	2 Points	3 Points
6 Clinical Signs				
Pretibial edema	0 Points	1 Point	2 Points	3 Points
Hyperpigmentation	0 Points	1 Point	2 Points	3 Points
Venous ectasia (venules or varicose veins)	0 Points	1 Point	2 Points	3 Points
Redness	0 Points	1 Point	2 Points	3 Points
Skin induration	0 Points	1 Point	2 Points	3 Points
Pain on calf compression	0 Points	1 Point	2 Points	3 Points
Venous ulcer		Absent		Present

Ginsberg measure, Brandjes scale

- Ginsberg measure
  - Presence of daily leg pain and swelling
    - Persist for at least 1 month
    - Typical characters (worse with standing or walking and relieved by rest or leg elevation)
  - Occurs at least 6 months after acute DVT
- Brandjes scale
  - Similar to the Villalta scale
  - Number of subjective and objective criteria
    - e.g. leg circumference

CEAP classification

- Society for Cardiovascular Surgery, North American Chapter
  - Clinical, etiological, anatomic, pathophysiological

Class	Clinical Signs
0	No visible or palpable signs of venous disease
1	Telangiectasiae or reticular veins
2	Varicose veins; distinguished from reticular veins by a diameter of ≥3 mm
3	Edema
4	Changes in skin and subcutaneous tissue secondary to CVD, now divided into 2 classes to better define the differing severity of venous disease:
4a	Pigmentation or eczema
4b	Lipodermatosclerosis or atrophie blanche
5	Healed venous ulcer
6	Active venous ulcer

Attribute	None=0	Mild=1	Moderate=2	Severe=3
Pain or other discomfort (ie, aching, heaviness, fatigue, soreness, burning): presumes venous origin		Occasional pain or other discomfort (ie, not restricting regular activity)	Daily pain or other discomfort (ie, interfering with but not preventing regular daily activities)	Daily pain or other discomfort (ie, limits most regular activities)
Varicose veins (>4 mm in diameter): varicose veins must be ≥3 mm in diameter to qualify in the standing position		Few: scattered (ie, isolated branch varicosities or clusters); also includes corona phlebectatica (ankle flare)	Confined to calf or thigh	Involves calf and thigh
Venous edema: presumes venous origin		Limited to foot and ankle area	Extends above ankle but below knee	Extends to knee and above
Skin pigmentation: presumes venous origin; does not include focal pigmentation resulting from other chronic diseases	None or focal	Limited to perimalleolar area	Diffuse over lower third of calf	Wider distribution (above lower third) and recent pigmentation
Inflammation: more than just recent pigmentation (ie, erythema, cellulitis, venous eczema, dermatitis)		Limited to perimalleolar area	Diffuse over lower third of calf	Severe cellulitis (lower third and above) or significant venous eczema
Induration: presumes venous origin of secondary skin and subcutaneous changes (ie, chronic edema with fibrosis, hyperdermitis); includes white atrophy and lipodermatosclerosis)		Limited to perimalleolar area	Diffuse over lower third of calf	Entire lower third of leg or more
Active ulcer number	0	1	2	>2
Active ulcer duration (longest active)	N/A	<3 mo	>3 mo but <1 y	Not healed for >1 y
Active ulcer size (largest active)	N/A	Diameter <2 cm	Diameter 2–6 cm	Diameter >6 cm
Use of compression therapy	Not used	Intermittent use of stockings	Wears stockings most days	Full compliance with stockings

J Vasc Surg. 2010;52:1387-96.

Objective diagnosis of PTS

- In the case of no significant history of DVT
  - Compression US
    - Evidence of prior DVT in popliteal or CF veins
  - CW doppler
    - Venous reflux
  - CT venography
- Suspected case of iliac vein obstruction
  - Chronic severe aching or entire leg swelling, lack of respiratory phasicity of CF CW
  - Cross-sectional imaging modalities
    - CT, MRI, contrast venography
- Residual venous abnormalities but no symptoms of PTS
  - Venous reflux, venous hypertension, internal venous trabeculation +
  - PTS should not be diagnosed

Risk factors of PTS

- At the time of diagnosis of DVT
  - Older age
  - Sex: male, female ?
  - Obesity
  - Proximal location of DVT
  - Thrombophilia
  - Varicose vein at baseline
  - Smoking daily before pregnancy
  - Asymptomatic DVT
  - Surgery within last 3 months
  - Provoked DVT
- During follow-up of DVT
  - Poor INR control
  - Ipsilateral DVT recurrence
  - Residual thrombus
  - Incomplete resolution of leg symptoms and signs at 1 month after DVT
  - OAC vs LMWH
  - Increased d-dimer
  - Elevated inflammation markers
  - Low physical activity
  - ?? Duration of OAC

Prevention of PTS

- Primary prevention
  - Pharmacological or mechanical thromboprophylaxis in high risk patients of DVT (IC)
- Secondary prevention
  - Appropriate intensity and duration of OAC to prevent recurrent ipsilateral DVT (IB)
- Optimizing anticoagulation
  - Appropriate INR with OAC (IB)
    - Especially, just after the DVT is essential treatment period.
  - Long term use of LWMH vs OAC (IIbB)
    - Ambiguous to reduce DVT
  - NOAC vs VKA (IIbC)
    - Ambiguous to reduce DVT

Prevention of PTS

- Compression to prevent PTS
  - Uncertain, but reasonable to reduce swelling in proximal DVT (IIbA)

Study, Year	Sample Size, n	Blinding	Time of Intervention After DVT	Type of Stocking	Duration of Follow-Up, y	Primary Outcome
Brandjes et al,[38] 1997	96 Stockings, 98 no stockings	No	2–3 wk	30 mm Hg at ankle; knee high	Up to 5	PTS by modified Villalta
Ginsberg et al,[9] 2001	24 Active stockings, 23 placebo stockings	Double-blinded	1 y	20–30 mm Hg knee-high	Up to 9	Daily pain and swelling
Prandoni et al,[51] 2004	90 Stockings, 90 no stockings	No	5–10 d	30–40 mm Hg	Up to 5	PTS by Villalta scale
Aschwanden et al,[12] 2008	84 Stockings, 85 no stockings	No	6 mo	26–36 mm Hg knee-high	Up to 7	Skin changes (CEAP ≥4)
Partsch et al,[88] 2004	18 Stockings plus walking, 18 Unna boot plus walking, 17 bed rest	No	At admission	30 mm Hg thigh-length	2	PTS by Villalta scale
Kahn et al,[53] 2014	410 Active stockings, 396 placebo stockings	Double-blinded	5–6 d	30–40 mm Hg knee-high	Up to 2	Daily pain and swelling

Prevention of PTS

- Thrombolysis/Endovascular Therapies to prevent PTS
  - Earlier and more complete thrombus clearance "open vein" concept
    - Reduction of venous outflow obstruction/venous hypertension, preserve valvular function
  - Systemic thrombolysis and anticoagulation vs anticoagulation alone
    - No apparent benefit to prevent PTS, significant elevation of major bleeding
  - Catheter directed thrombolysis (CDT), pharmacomechanical CDT (PCDT)
    - Low to medium quality studies
    - Not recommended for routine first-line use for the purpose of PTS reduction
    - Selected patients with acute symptomatic iliofemoral DVT in experienced centers
      - Limb salvage in the rare patients with acute limb-

Prevention of PTS

- Surgical venous embolectomy in IF-DVT
  - Scandinavian multicenter RCT in 41 acute IF-DVT patients
    - venous thrombectomy and temp. AVF compared to single anticoagulation in IF-DVT
      - Improvement of iliac vein patency
      - Lowering venous pressures
      - Reduction of leg edema
      - Fewer PTS

Eur J Vasc Surg. 1990;4:483-9.

CDT in IF-DVT and QoL

- Retrospective QoL assessment in IF-DVT
  - CDT and anticoagulation (n=60) vs single anticoagulation (n=30)

Table II. Mean scale scores posttreatment

*Scale item**	*Urokinase* (*mean ± SE*)	*Heparin* (*mean ± SE*)	P *value*
Intial contact mean, 16 months	N = 68	N = 30	
Health Utilities Index	0.81 ± 0.02	0.73 ± 0.03	.078
Health interference	73.47 ± 3.09	66.47 ± 4.71	.23
Role functioning physical	70.78 ± 3.62	57.06 ± 5.56	.046
Stigma	83.54 ± 3.07	71.13 ± 4.72	.033
Health distress	78.20 ± 3.20	64.36 ± 4.87	.022
Overall symptoms	71.40 ± 2.95	55.80 ± 4.50	.006
Follow-up mean, 22 months	N = 48	N = 13	
Health Utilities Index	0.73 ± 0.03	0.74 ± 0.07	.94
Health interference	69.52 ± 4.35	65.58 ± 8.58	.69
Role functioning physical	64.12 ± 4.42	56.59 ± 8.60	.45
Stigma	82.15 ± 3.92	67.44 ± 7.81	.10
Health distress	74.65 ± 3.84	55.91 ± 7.65	.036
Overall symptoms	67.74 ± 3.56	50.68 ± 7.30	.044

Adjusted for propensity scores (education, marital status, age) and number of days since hospitalization.
*Higher scores represent higher functioning/less interference/fewer symptoms/less distress.

J Vasc Surg. 2000;32:130-7.

CDT in IF-DVT and QoL

- Retrospective QoL assessment in IF-DVT
  - CDT and anticoagulation (n=60) vs single anticoagulation (n=30)

Table III. Mean scale scores of thrombolysis group by degree of lysis

*Scale item**	*Groups*			
	Failure (mean ± SE)	*Partial (mean ± SE)*	*Complete (mean ± SE)*	P *value*
Initial contact mean, 16 months	N = 8	N = 25	N = 18	
Health Utilities Index	0.78 ± 0.06	0.81 ± 0.03	0.85 ± 0.04	.46
Health interference	67.53 ± 8.56	72.43 ± 4.90	82.90 ± 5.64	.24
Role functioning physical	58.22 ± 10.50	72.84 ± 5.88	79.19 ± 6.91	.26
Treatment satisfaction	77.27 ± 9.43	91.22 ± 5.28	81.10 ± 6.21	.31
Stigma	74.14 ± 8.24	83.41 ± 4.62	90.56 ± 5.42	.25
Health distress	58.68 ± 7.73	81.63 ± 4.33	83.88 ± 5.09	.024
Overall symptoms	52.71 ± 7.12	78.33 ± 3.99	79.50 ± 4.68	.006
Follow-up mean, 22 months	N = 5	N = 19	N = 13	
Health Utilities Index	0.69 ± 0.10	0.66 ± 0.05	0.83 ± 0.06	.14
Health interference	56.52 ± 13.08	63.13 ± 6.71	81.70 ± 8.44	.16
Role functioning physical	49.29 ± 13.82	72.51 ± 7.72	62.77 ± 8.56	.33
Stigma	61.70 ± 10.08	92.88 ± 5.17	83.47 ± 6.24	.032
Health distress	50.24 ± 11.28	84.08 ± 5.79	73.17 ± 6.99	.038
Overall symptoms	53.52 ± 10.25	74.68 ± 5.40	73.94 ± 6.35	.18

Adjusted for propensity scores (education, marital status, age) and number of days since hospitalization.
*Higher scores represent higher functioning/less interference/fewer symptoms/less distress.

J Vasc Surg. 2000;32:130-7.

Lesser residual thrombus, lesser PTS

- In prospective CDT in acute IF-DVT
  - Residual thrombus burden after CDT (< 50% vs > 50% in phlebogram)

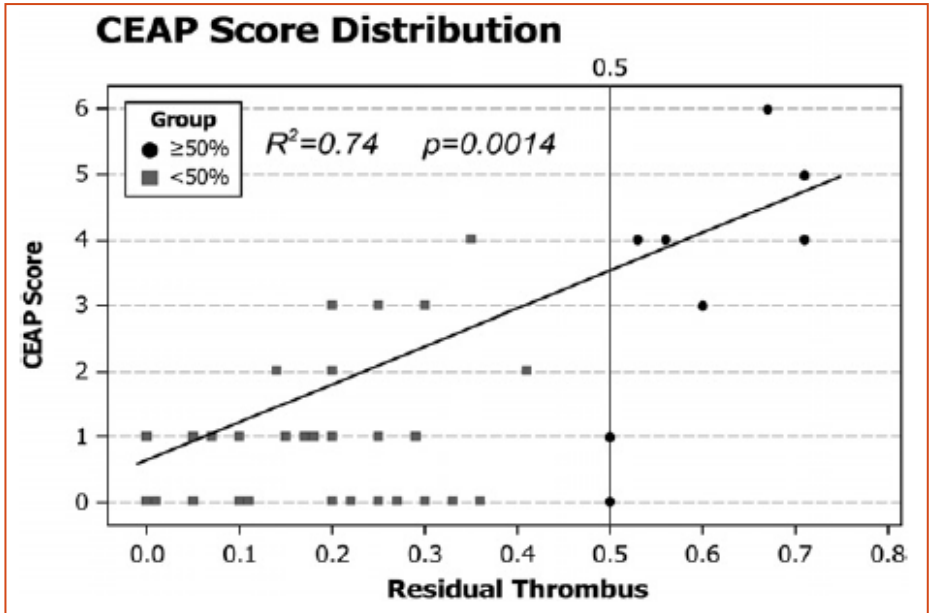


Fig 1. Plot of clinical class of CEAP at follow-up vs residual thrombus at treatment end. Data points may represent more than one patient.

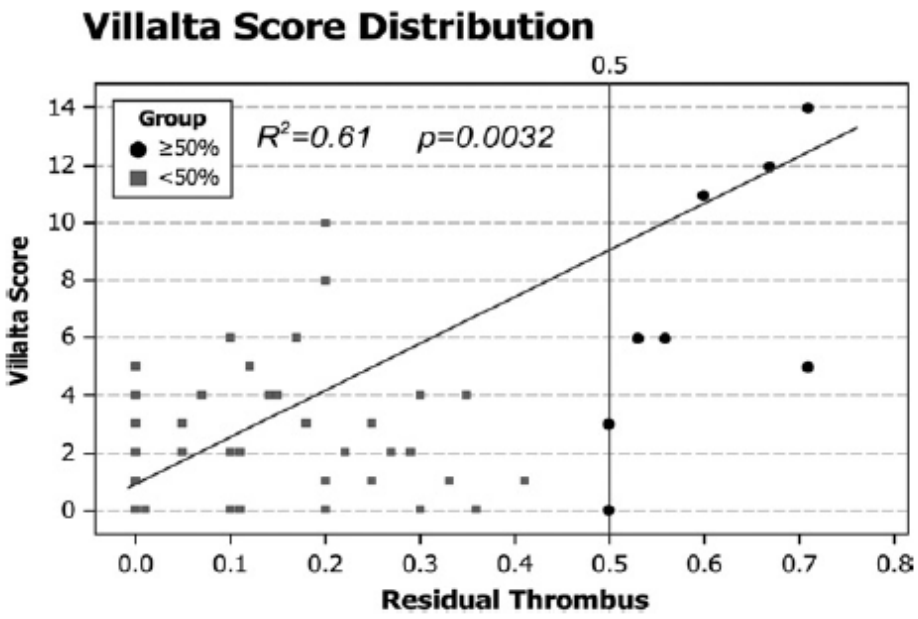
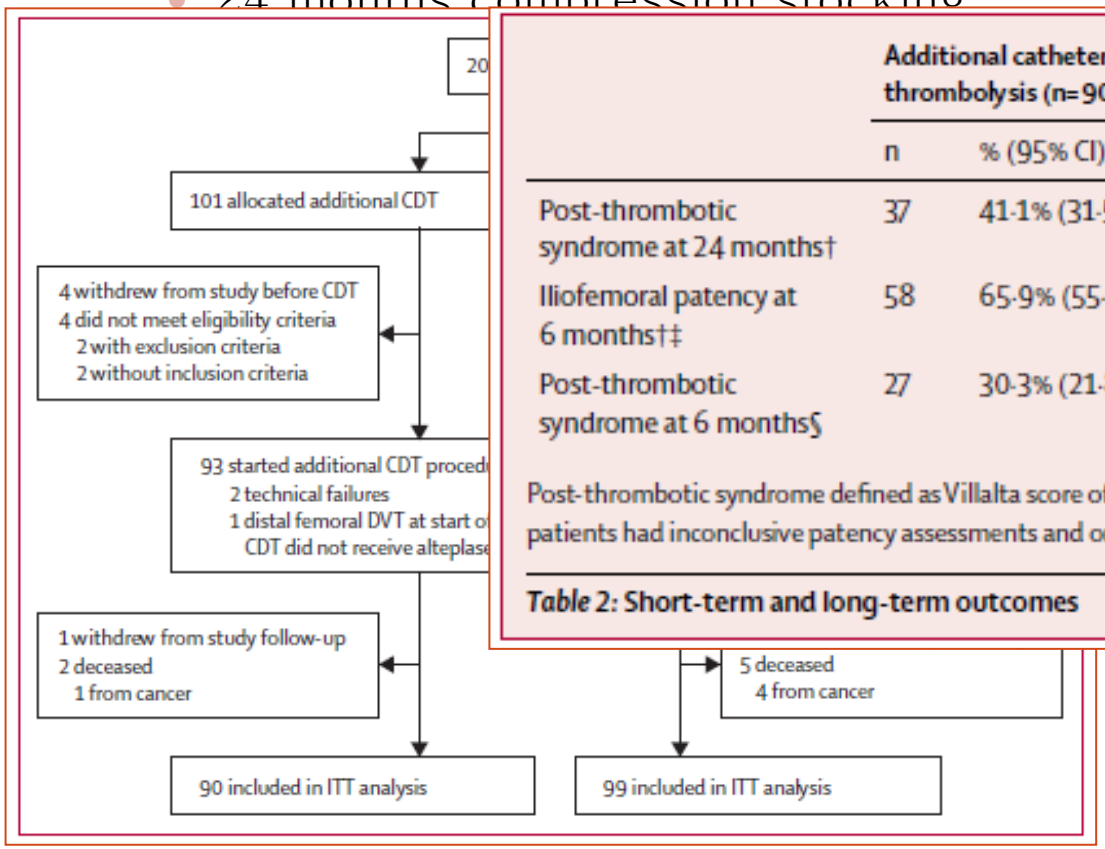


Fig 2. Plot of Villalta score at follow-up vs residual thrombus at treatment end. Data points may represent more than one patient.

J Vasc Surg. 2012;55:768-73.

CaVenT: CDT effect on anticoagulation

- RCT with 209 acute IF-DVT (Villalta scale)
  - Add CDT on usual anticoagulation reduced PTS on 2 years follow up
    - 24 months compression stocking



	Additional catheter-directed thrombolysis (n=90)		Standard treatment only (n=99)		p value*
	n	% (95% CI)	n	% (95% CI)	
Post-thrombotic syndrome at 24 months†	37	41·1% (31·5–51·4)	55	55·6% (45·7–65·0)	0·047
Iliofemoral patency at 6 months†‡	58	65·9% (55·5–75·0)	45	47·4% (37·6–57·3)	0·012
Post-thrombotic syndrome at 6 months§	27	30·3% (21·8–40·5)	32	32·2% (23·9–42·1)	0·77

Post-thrombotic syndrome defined as Villalta score of 5 points or higher. *χ^2 test. †Co-primary outcomes. ‡Five patients had inconclusive patency assessments and one was lost to follow-up at 6 months. §Secondary outcome.

Table 2: **Short-term and long-term outcomes**

Lancet 2015;203:23

Treatment of PTS

- Graduated ECS and intermittent compression
  - Trial of ECS: considered in patients with PTS who have no contraindications (IIbC)
  - Trial of ICD: reasonable for mod. to severe PTS and significant

Table 7. RCTs of Graduated Compression Stockings to Prevent PTS

Study, Year	Sample Size, n	Blinding	Time of Intervention After DVT	Type of Stocking	Duration of Follow-Up, y	Primary Outcome
Brandjes et al,[38] 1997	96 Stockings, 98 no stockings	No	2–3 wk	30 mm Hg at ankle; knee high	Up to 5	PTS by modified Villalta
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CEAP indicates clinical, etiological, anatomic, pathophysiological; DVT, deep venous thrombosis; PTS, postthrombotic syndrome; and RCT, randomized, controlled trial.

Treatment of PTS

- Pharmacological therapy for PTS
  - Rutoside, Defibrotide, Hidrosmin
  - Effectiveness and safety of those drugs to treat PTS are uncertain (II, B)

Table 9. Pharmacotherapy for the Treatment of PTS

Study, Year	Design	Population	Intervention	Control	Follow-Up	Results
de Jongste et al,[111] 1989	Parallel-group RCT	83 Patients with PTS of ≥6-mo duration; minimum 10-mm difference in calf/ankle circumference between PTS leg and other leg	HR 1200 mg daily (4 equal doses) for 8 wk	Placebo 4 times daily; use of GCS not allowed	8 wk (4- and 8-wk follow-up visits)	Greater improvement of symptoms* seen in HR group at 4 and 8 wk (only tiredness was statistically significant, P=0.02). Greater reduction in mean calf (−6.7 mm) and ankle (−3.4 mm) circumference at 8 wk in HR group.
Monreal et al,[113] 1994	Crossover RCT	29 Patients with PTS of ≥12-mo duration; minimum 20-mm difference in calf/ankle circumference between PTS leg and other leg	Hidrosmin 600 mg daily (3 equal doses) for 6 mo; HR 900 mg daily (3 equal doses) for 6 mo	All subjects took both study drugs; all were encouraged to use GCS	18 mo; study period of 6 mo and then follow-up every 3 mo	Improvement of symptoms† with both drugs. Small reduction in calf/ankle circumference with hidrosmin. Ulcer healing with both drugs.
Coccheri et al,[112] 2004	Parallel-group RCT	288 Patients with CEAP class C2-C4 venous disease; only 64% had history of DVT	Defibrotide, 800 mg daily (2 equal doses) for 12 mo	Placebo twice a day; GCS used by both groups	12 mo (follow-up visits every 2 mo)	Improvement in symptoms,‡ statistically significant for pain (*P*=0.01) and edema (*P*=0.03). Decreased mean ankle circumference over 12 mo in treatment group (*P*=0.0013)
Frulla et al,[49] 2005	Parallel-group RCT (3 arms)	120 Patients with PTS (defined by Villalta scale) and previous proximal DVT	HR 1,000 mg twice daily (soluble powder) alone or combined with GCS (30-40 mm Hg) for 12 mo	GCS (30-40 mm) for 12 mo	12 mo (follow-up visits at 3,6,12 mo)	1) PTS improvement§: 26/40 HR, 25/40 CGS + HR, 28/40 GCS alone 2) PTS worsening: 9/40 HR, 9/40 GCS + HR, 6/40 GCS alone

Treatment of PTS

- Exercise training for PTS
  - Exercise training with supervisor at least 6 months duration is reasonable. (IIaB)

- Venous ulcer treatment
  - ~10% of PTS patient: develop severe PTS, venous ulcer
    - Compression therapy, primary compression dressing (IA)
    - Multicomponent compression (IB)
    - Pentoxifylline (IIaA)
    - Neovalve reconstruction surgery in refractory PTS (IIbC)

Treatment of PTS

- Venous ulcer treatment
  - Various stage of venous ulcer in PTS and importance of multilayered compression

Treatment of PTS

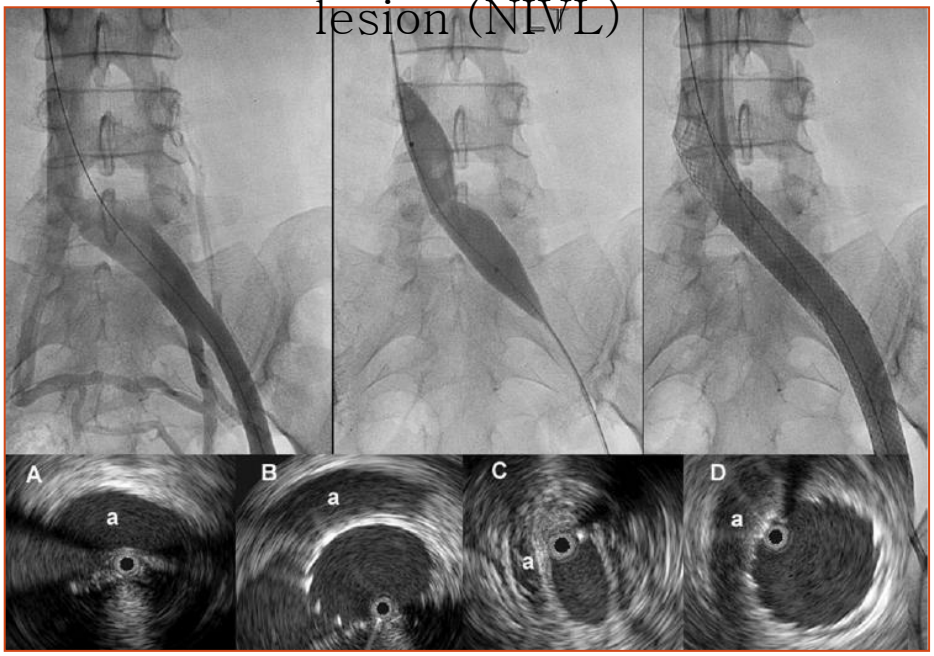
- Surgical treatment
  - Infrainguinal venous obstruction
    - Saphenopopliteal , Saphenotinila bypass for occluded femoral or popliteal vein
      - 4 studies in 125 patients, patency: 50~97%, clinical benefit: 31~75% (6~125 mo)
  - Iliofemoral obstruction
    - Femoro-femoral bypass with contralat. SV (Palma operation)
      - Patency: 37~100%, clinical benefit : 25~100% (6~144 mo)
    - Femoro-femoral bypass with prosthetic graft
      - Patency and clinical success: 25~100% (1~123 mo)
  - 26 Femoro-iliac/iliocaval bypass, 9 femoro-caval bypass
    - 41 mo follow up , 53%: no or minimal swelling, no activity limitation
    - Ulcer: healed in 83% (12 mo), recurred in 50% (48 mo)

J Cardiovasc Surg. 1991;32:98-103. J Vasc Surg.

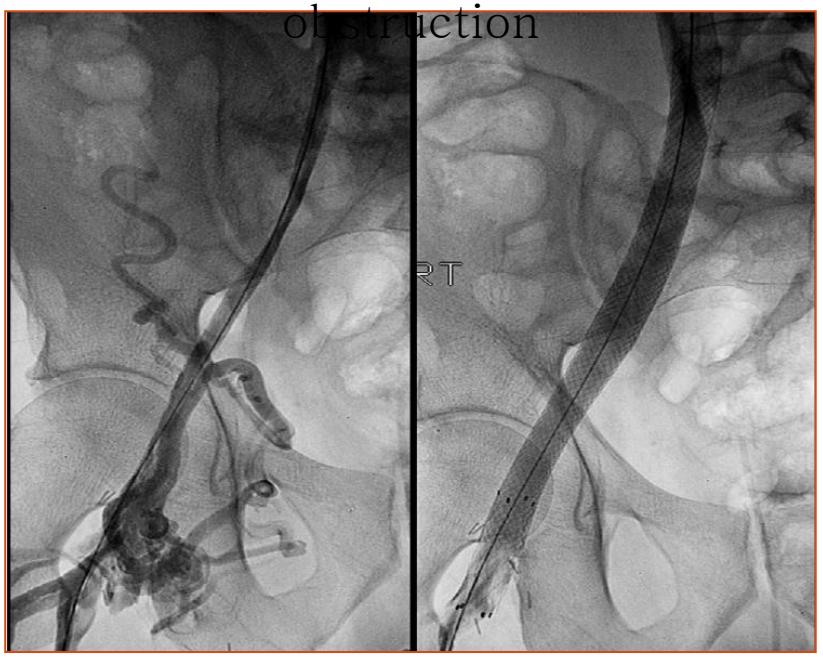
Treatment of PTS

- Endovascular procedures for femoroiliocaval obstruction
  - 982 stented case of chronic nonmalignant obstructive venous disease in `97~`02

Stenting for nonthrombotic iliac vein lesion (NIVL)



Stenting for iliofemoral obstruction



J Vasc Surg. 2007;46:970-90.

Treatment of PTS

- Endovascular procedures for femoroiliocaval obstruction
  - 982 stented case of chronic nonmalignant obstructive venous disease in `97~`02

Patency of stenting for iliofemoral obstruction

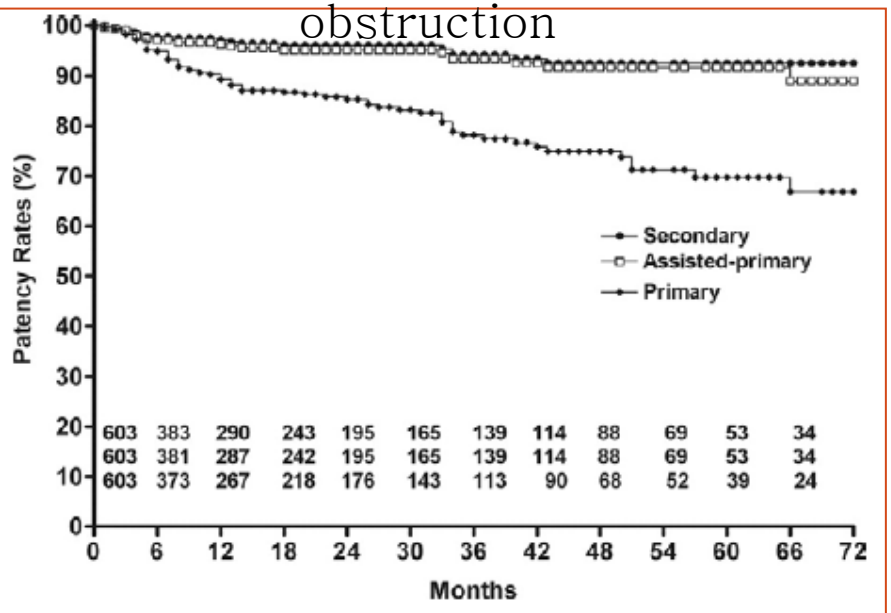


Fig 3. Cumulative primary, assisted-primary, and secondary patency rates of 603 limbs after iliofemoral stenting. The lower numbers represent limbs at risk for each time interval (all standard error of the mean <10%).

Patency of stenting for NIVL

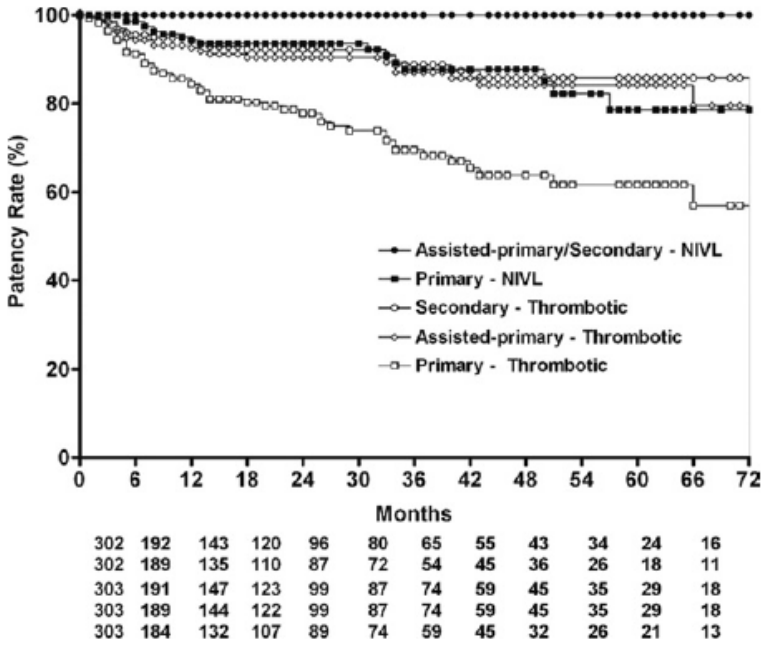


Fig 4. Cumulative primary, assisted-primary, and secondary patency rates for stented limbs with nonthrombotic iliac vein lesions *(NIVL)* and those with previous thrombosis. The lower numbers represent total limbs at risk for each time interval (all standard error of the mean <10%).

J Vasc Surg. 2007;46:970-90.

Treatment of PTS

- Endovascular procedures for femoroiliocaval obstruction
  - 982 stented case of chronic nonmalignant obstructive venous disease in `97~`02

Cumulative rates of severe ISR

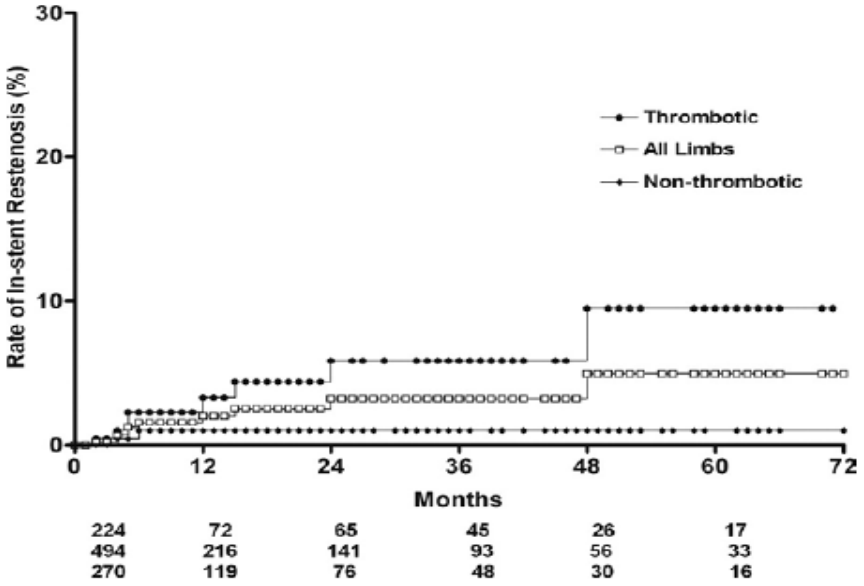


Fig 5. Cumulative rates of severe in-stent restenosis (>50% narrowing) in the entire study group for limbs stented for postthrombotic lesions (thrombotic) and for limbs stented for obstruction caused by nonthrombotic iliac vein lesions. The lower numbers represent total limbs at risk for each time interval (all standard error of the mean <10%).

Predicting factor for stent occlusion

Table I. Odds ratios for possible factors contributing to early (<30 days) or late occlusions of inserted stents

Factor	*Occluded, frequency, No. (%)*	*Odds ratio**	P†	*Missing values*
Operation side		1.1	.8395	
Left	22 (5.0)			
Right	9 (5.3)			
Etiology of obstruction		—	<.0001	
NIVL	0 (0.0)			
Thrombotic	31 (10.1)			
Degree of obstruction		9.0	<.0001	
Occlusion	12 (24.0)			
Non-occlusive obstruction	19 (3.4)			
Thrombophilia test		1.2	.8261	159
Negative	17 (5.5)			
Positive	7 (4.8)			
Stent extended to CFV		3.8	.0010	
Yes	12 (12.8)			
No	19 (3.7)			
Gender		1.4	.4090	
Female	21 (4.7)			
Male	10 (6.3)			
Additional procedures		1.9	.3670	
Yes	4 (5.6)			
No	27 (3.1)			

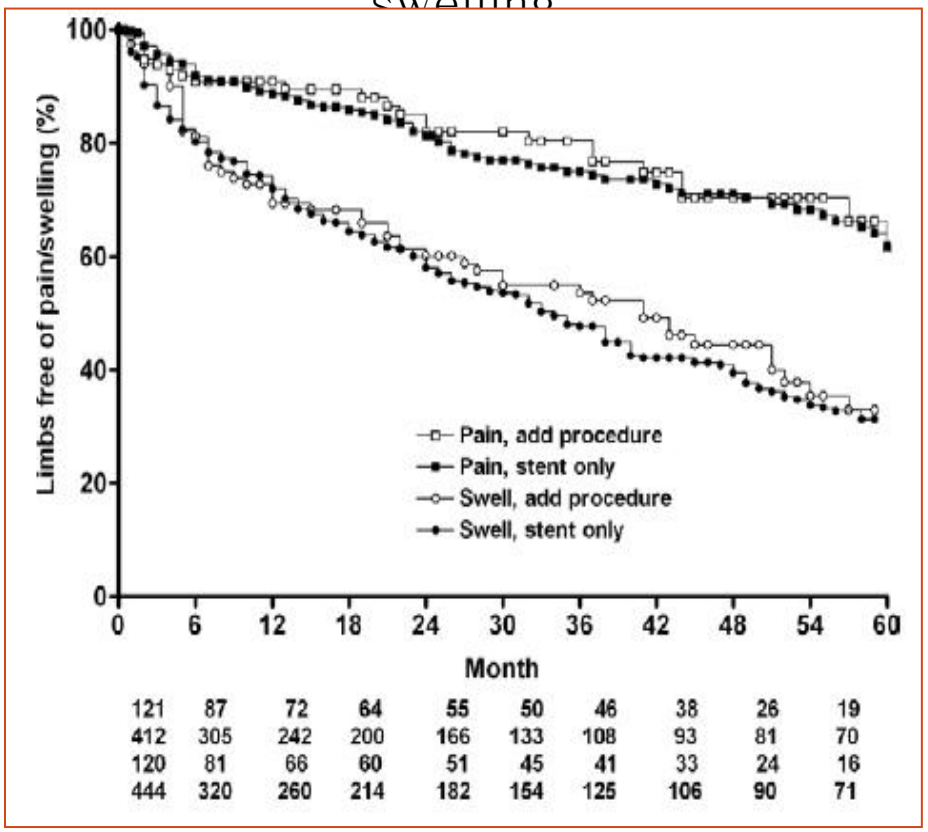
NIVL, Nonthrombotic iliac vein lesion; *CFV*, common femoral vein.
*Effect was computed as odds ratio.
†Computed by the Fisher exact test.

J Vasc Surg. 2007;46:970-90.

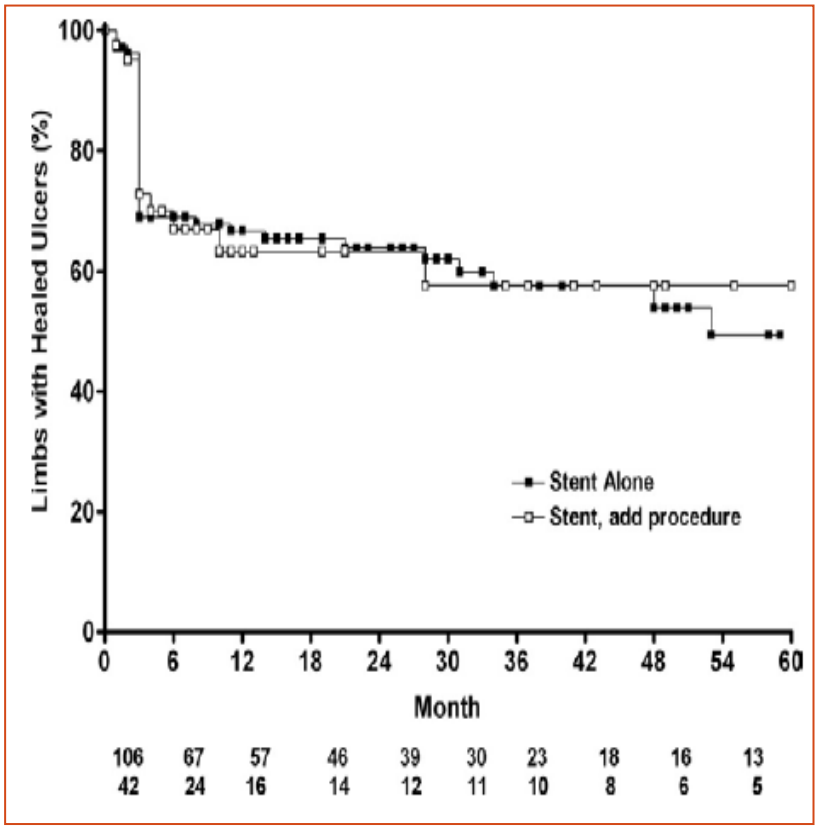
Treatment of PTS

- Endovascular procedures for femoroiliocaval obstruction
  - 982 stented case of chronic nonmalignant obstructive venous disease in `97~`02

Sustained complete relief of pain and swelling



Cumulative rate of healed ulcer



J Vasc Surg. 2007;46:970-90.

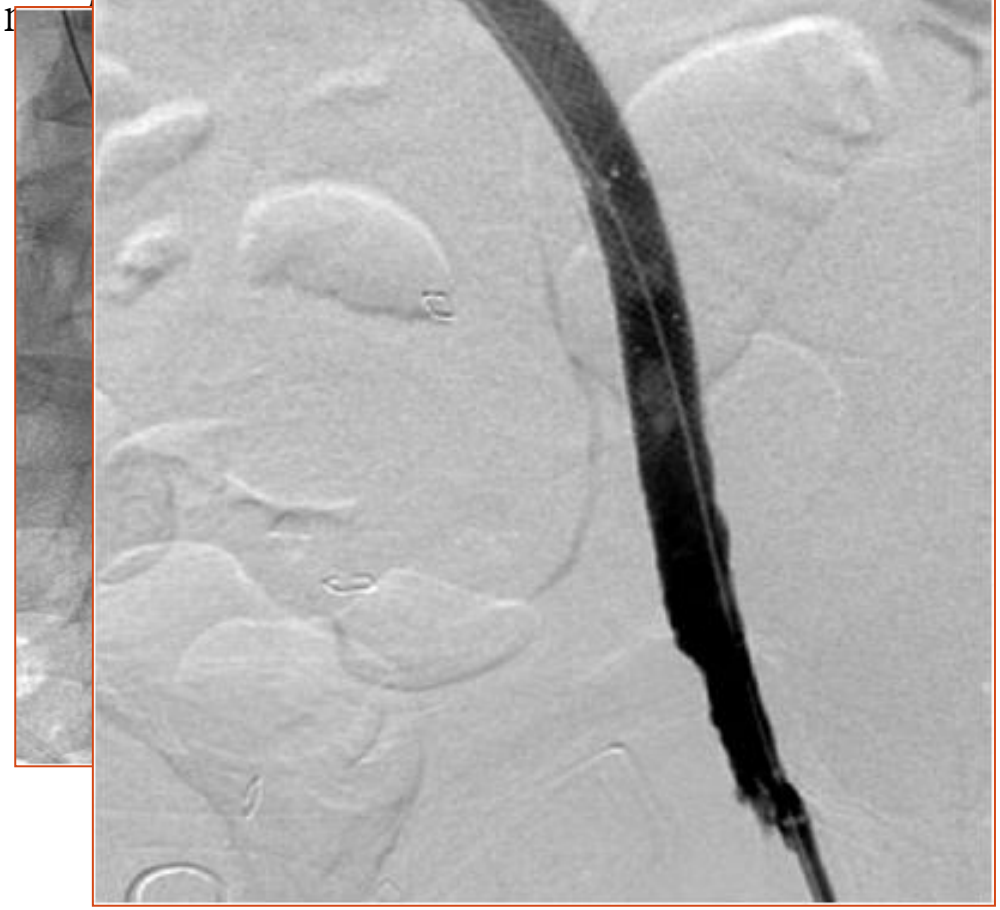
Iliac vein stenting for PTS

- Meta-analysis for chronic iliac vein stenosis and occlusion
  - ~1500 cases of open and hybrid reconstruction and simple stenting
  - Nonthrombotic iliac vein lesion, PTS
  - Results
    - Safety: procedure related morbidity < 1%
    - Patency: 90~100% for NIVL, 74~89% in PTS at 3~5 years
    - Relief of pain: 86~94%
    - Relief of swelling: 66~89%
    - Healing of venous ulcer: 58~89%
    - Success of recanalization for CTO: 83~95%
    - Hybrid techniques for complex case: in evolution

J Vasc Surg. 2013;57:1163-9.

Treatment of PTS

- In the case of chroni …cedure
  - CFV stenting beyon… …ent thrombosis and frac…



J Vasc Surg 2010;52:243-7.

Treatment of PTS

- Surgical procedures to correct reflux
  - Segmental vein valve transfer
    - axillofemoral/popliteal transplantation or venous transposition
    - 51 extremities (48 patients), 4~21 years follow up

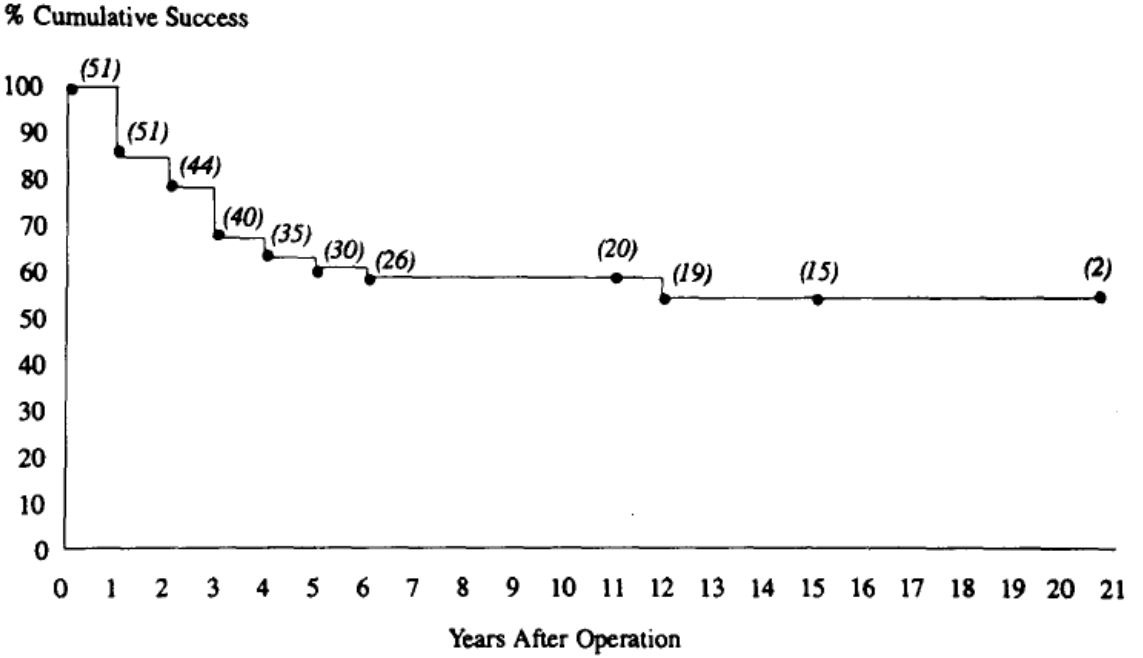


Fig. 1. Cumulative clinical success rate of achieving class 0 or 1 result after venous valve reconstruction for all limbs. Number in parentheses represent total limbs at risk for each time interval.

J Vasc Surg 1994;19:391-403.

Treatment of PTS

- Endovascular and surgical treatment for PTS
  - Open the iliac vein, and correct valve reflux when PTS with open iliac vein

Table 10. Endovascular, Surgical, and Hybrid Approaches to the Treatment of PTS*

	Indication	Approach
Endovascular approaches	Iliocaval/iliofemoral obstruction	Venoplasty and stenting
	Correction of superficial reflux	Endovenous thermal ablation
Surgical approaches	Infrainguinal venous obstruction	Saphenopopliteal bypass Saphenotibial bypass
	Iliofemoral obstruction	Femoro-femoral bypass Femoroiliac bypass Iliocaval bypass Femoral-caval bypass
	Correction of reflux	Segmental vein valve transfer via axillofemoral/popliteal transplant or venous transposition Ligation of femoral vein
Hybrid approaches	Femoral and iliac vein reconstruction	Surgical endophlebectomy of common femoral vein with patch angioplasty and endoluminal balloon venoplasty and stenting of iliac veins and vena cava Adjunctive arteriovenous fistula to maintain patency Surgical disobliteration of common femoral vein to more effectively drain infrainguinal venous system and provide inflow to recanalized iliac veins

Iliac vein compression (May-Thurner) syndrome

- Endovascular therapy in 23 MTS patients (follow up 15 ±16 mo)
  - Etiology: chronic compression of left iliac vein between right CIA and lumbar spine
    - Collagen scar in iliac vein and occlusion of left iliac vein
    - Surgical therapy: out dated, single OAC: ineffective
      - Surgical therapy: 3 year patency – primary 54%, secondary 62%
  - Recent treatment regimen
    - Thromboaspiration, CDT, PTA, stenting

Table 2 Results at the last follow up visit

Symtomatic status	Number of Patients (n: 23)	Percentage (%)
Complete resolution	19	82.6
Improvement	3	13
No change	1	4.4
Stent patency	**Number of patients (n: 21)**	**Percentage (%)**
Complete	19	90.4
Restenosis	2	9.6

Ann Vasc Dis. 2015;8:21-28.

Treatment of PTS

- Endovascular and surgical treatment for PTS
  - Severe PTS with iliac or VC obstruction
    - Endovascular therapy-angioplasty, stenting (IIbB)
    - Surgical therapy (IIbC)
  - Severe PTS with CF, iliac, and VC obstruction
    - Combined therapy with endovascular and surgery (IIbC)
  - Severe PTS with segmental vein valve transfer or venous transposition (IIbC)

Conclusion

- Prevention is the best measure.
  - Early detection, and aggressive treatment for acute DVT.
    - CDT, aspiration thrombectomy, angioplasty and stenting should be considered.
    - Appropriate anticoagulation should be maintained.
    - Elastic stocking and rehabilitation must be performed.
- Objective surveillance with clinical index is very important.
- Endovascular treatment should be the first treatment option.
  - Simple anticoagulation, and compression is not enough.
  - Surgical intervention is risky and invasive.
  - Iliac and femoral vein stenting is durable.
  - Hybrid procedure for iliac vein PTA are evolving.
- Cause of chronic DVT should be defined.