Measurement of Edema Using Volumetric Plethysmography

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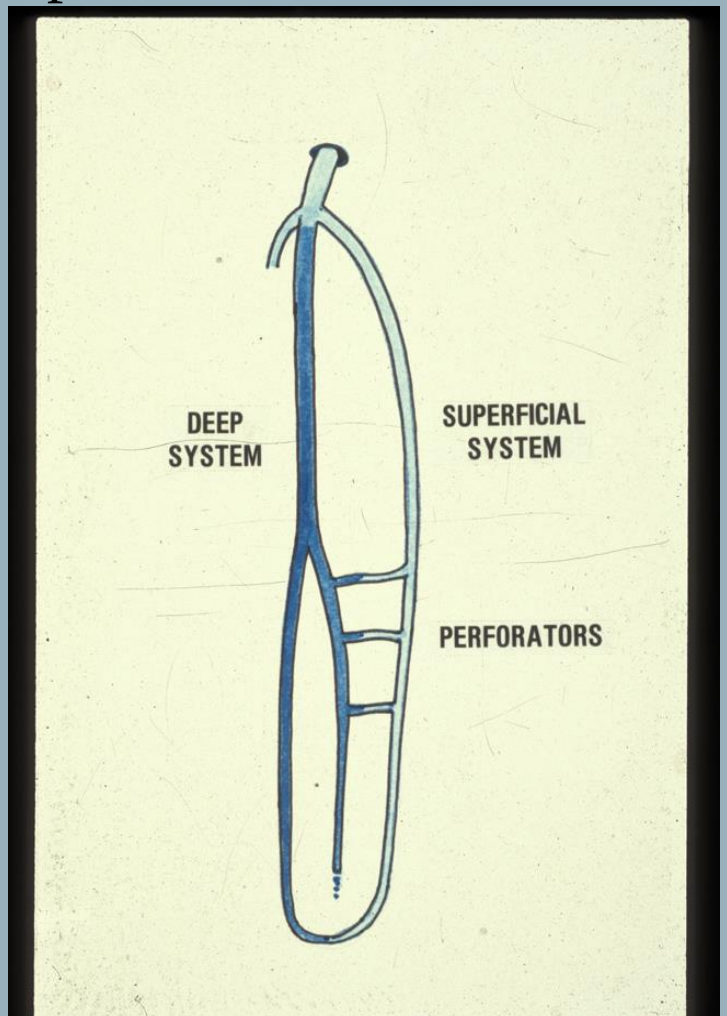
Disclosures

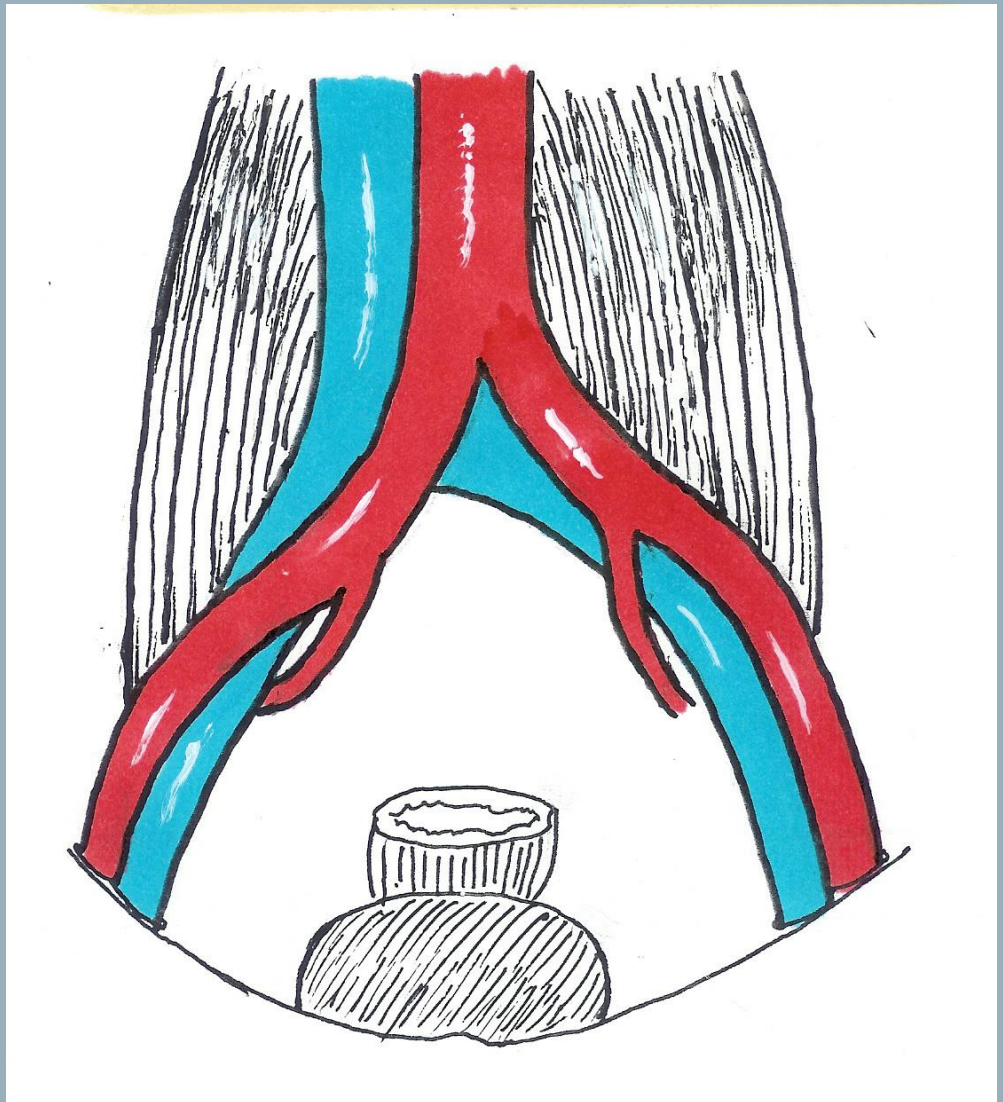
- Nothing to disclose.

Venous symptoms result from either obstruction or reflux involving deep and/or superficial system. Size matters. Obstruction and reflux in the deep system is usually significant. The saphenous has to be large (>5 cm) to cause significant reflux. Superficial obstruction is inconsequential. Detailed investigations beyond Doppler is required for proper identification of Pathology

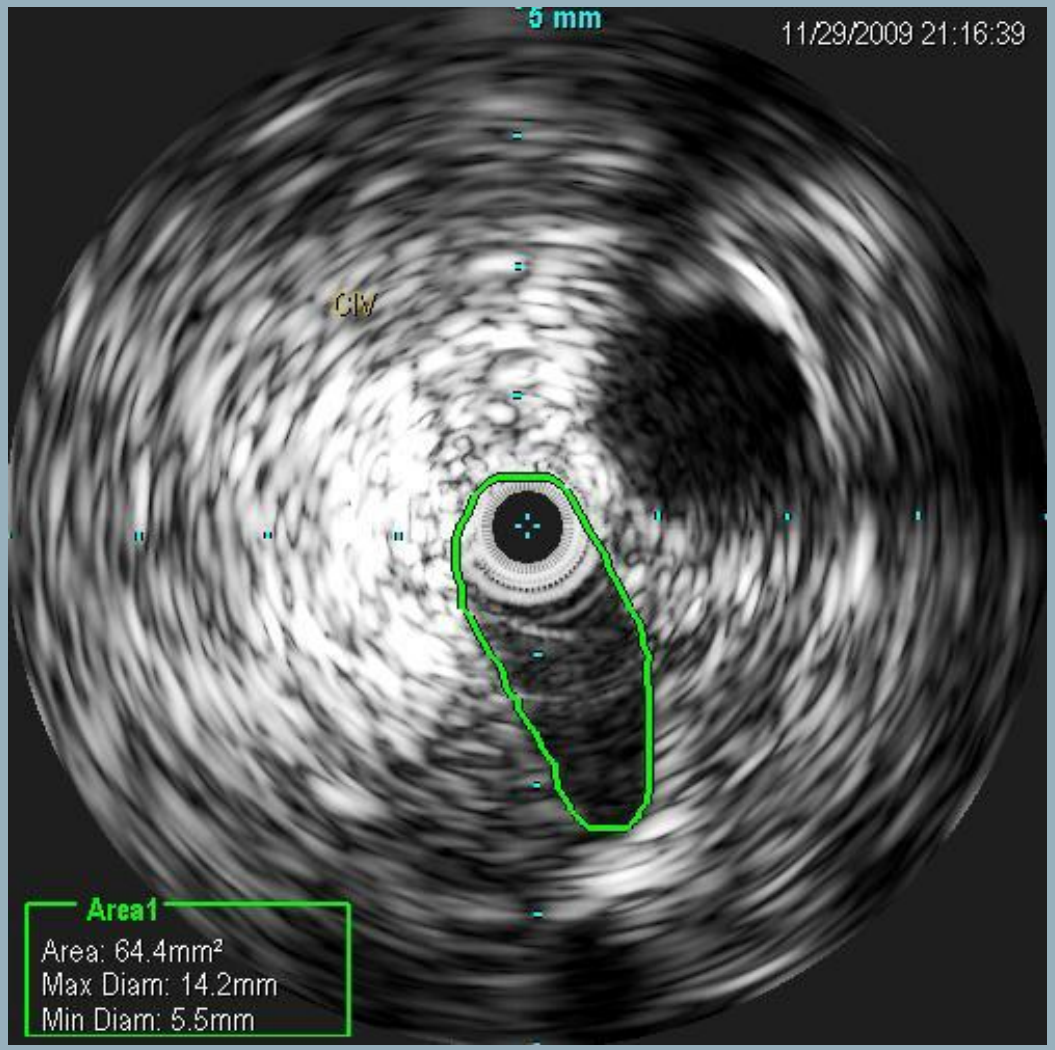


This is not from saphenous reflux. Even a very large saphenous reflux results only in ankle edema. Indiscriminate saphenous ablation in “Vein Clinics” currently is a widespread unchecked practice abuse

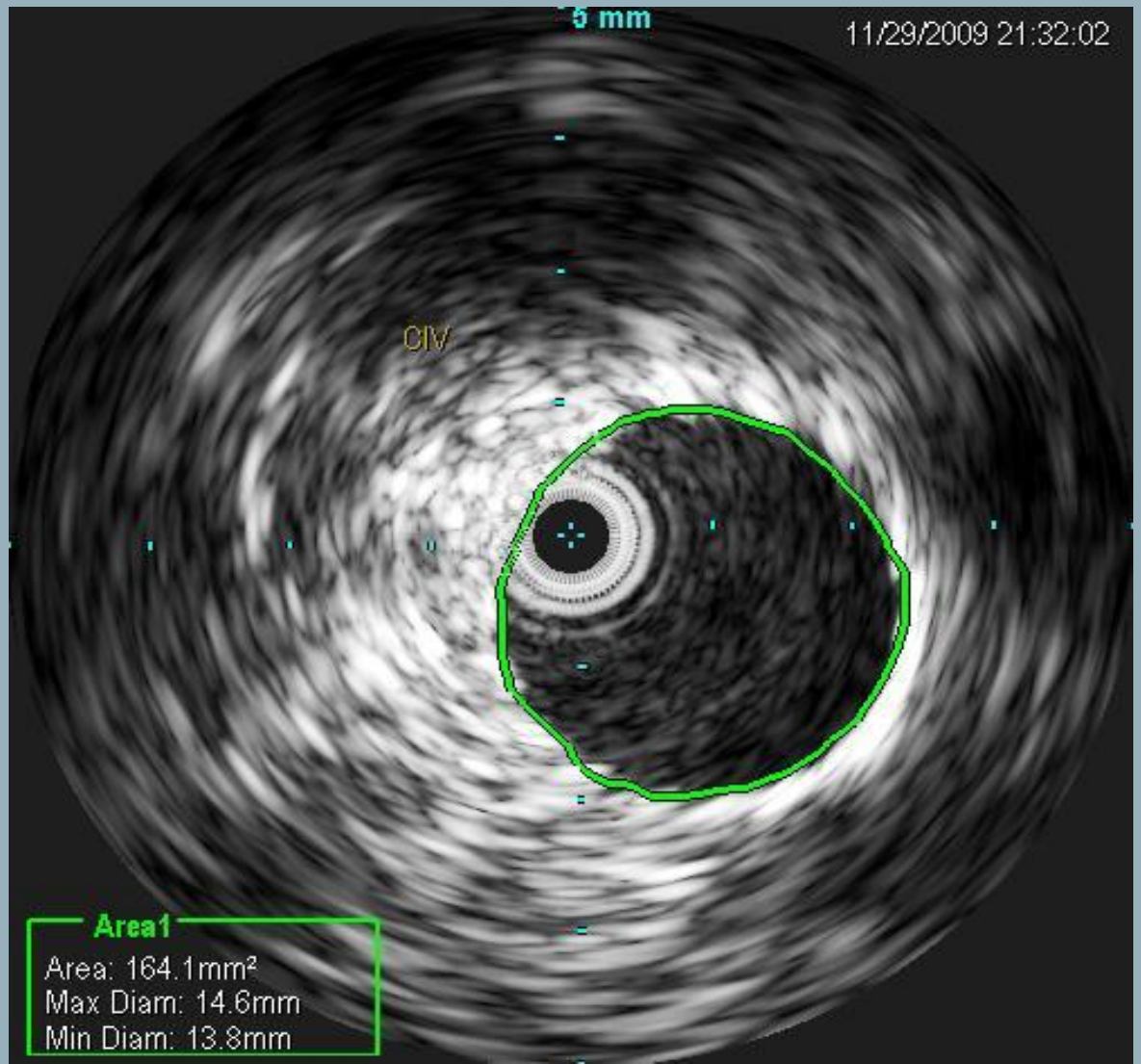
“Classic May-Thurner lesion” beneath right iliac artery crossing. (NIVL)



The vein is not merely compressed, there is fibrosis from the trauma of arterial pulsations



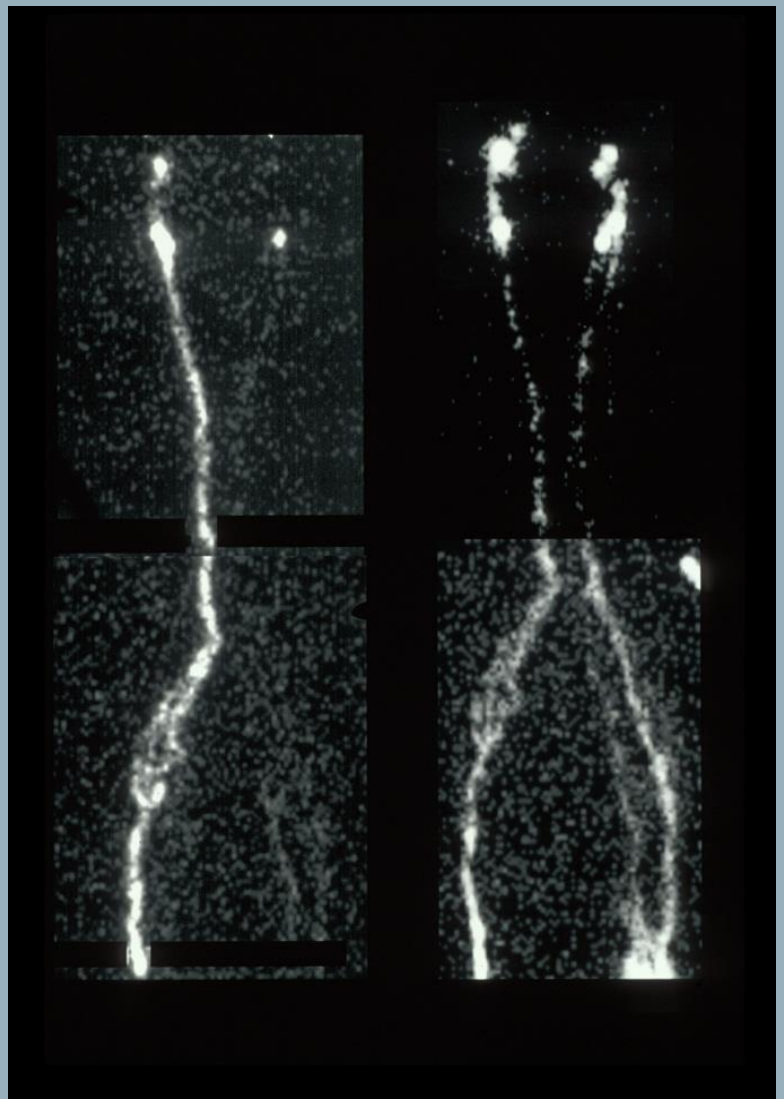
Correction of May-Thurner lesion by stent



In the younger patient, swelling is a quality of life issue. Proper footwear is a big issue. Painful leg swelling is highly symptomatic. Some patients will tolerate lot of swelling if painless.

“Classic” clinical signs of lymphedema are unreliable; venous swelling can mimic them. This one had a May-Thurner with normal lymphngiogram.

30% of May-Thurner cases will have secondary lymphedema due to lymphatic overload. Probably the commonest cause of lymphedema in US. See lymphatic recovery after stent correction.



May-Thurner lesions are common, occurring in about 30% of the population. They are silent in most but become symptomatic when decompensated by secondary pathology.

- This is an example of a permissive pathology.
- Some other examples of permissive lesions :
  - Obesity & Diabetes
  - Diabetes & Neuropathy
  - Carotid stenosis & TIA
  - Ureteric reflux & pyelonephritis
  - PFO & Stroke
  - esophgeal reflux & Asthma
- Correction of the permissive lesion alone often results in remission, even when the secondary pathology is not addressed.

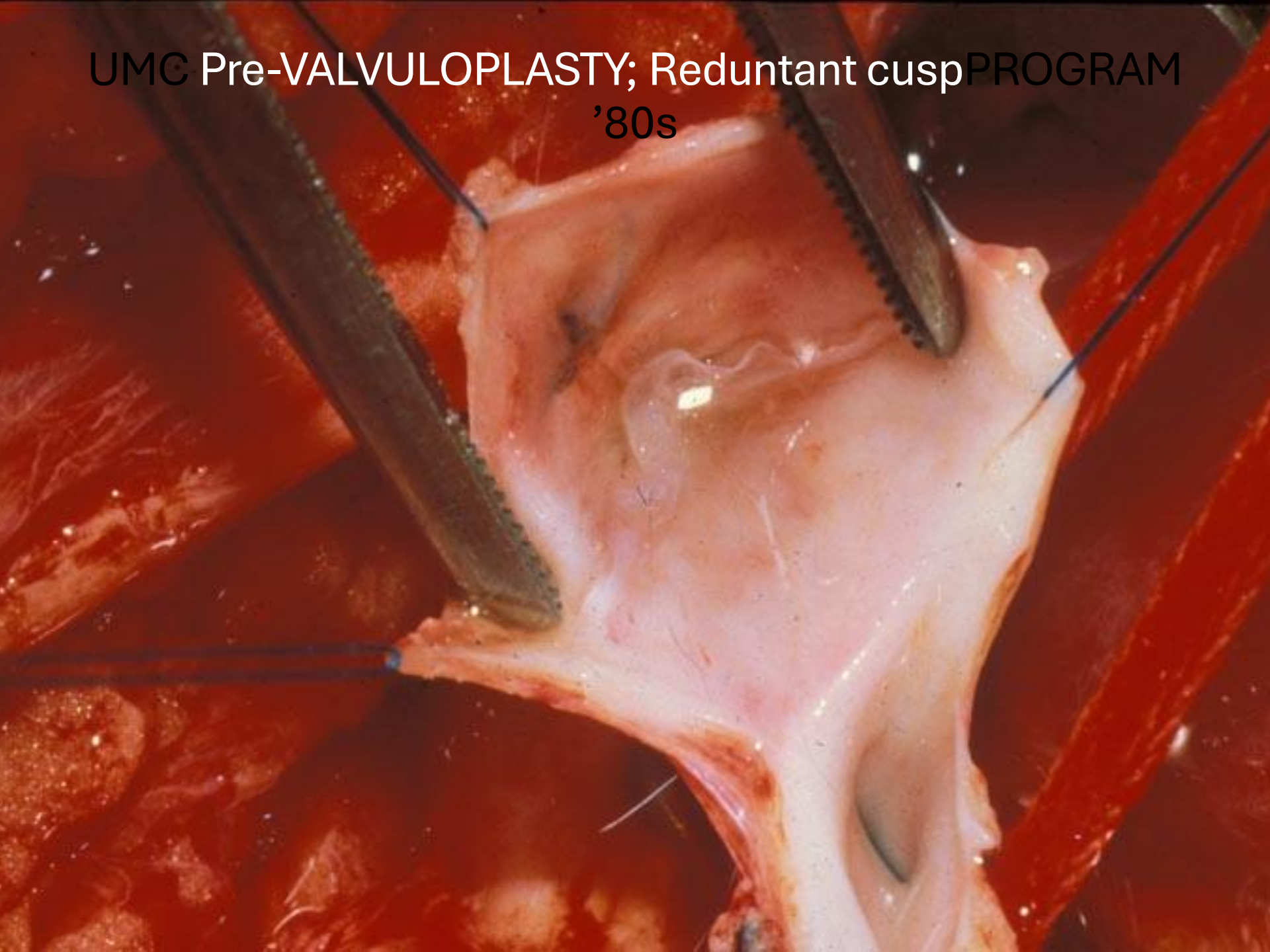
All had silent May-Thurner but sudden onset of new leg swelling with secondary insult.

Trauma

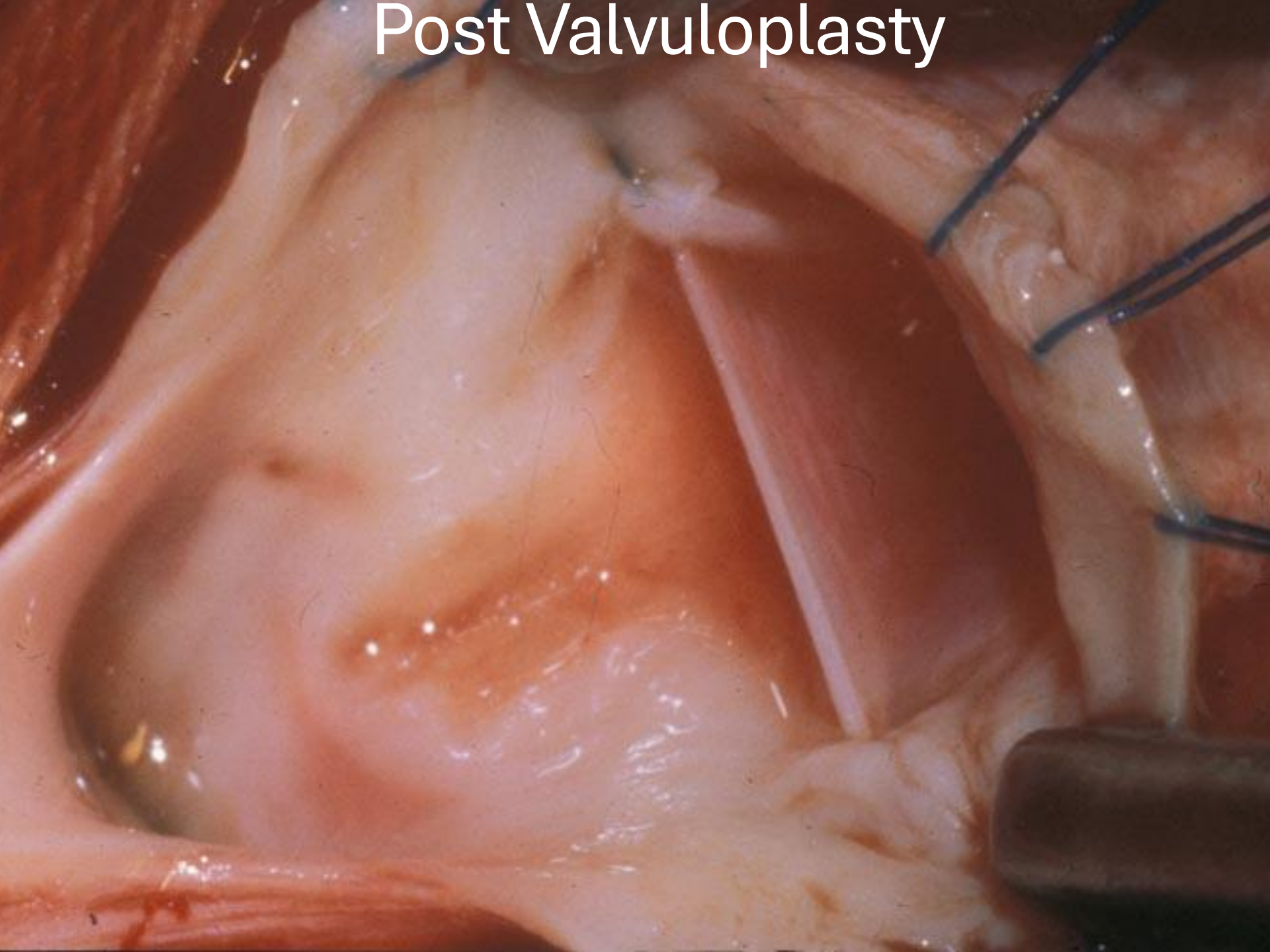
Cellulitis

Joint Replacement

UMC Pre-VALVULOPLASTY; Reduntant cuspPROGRAM ’80s



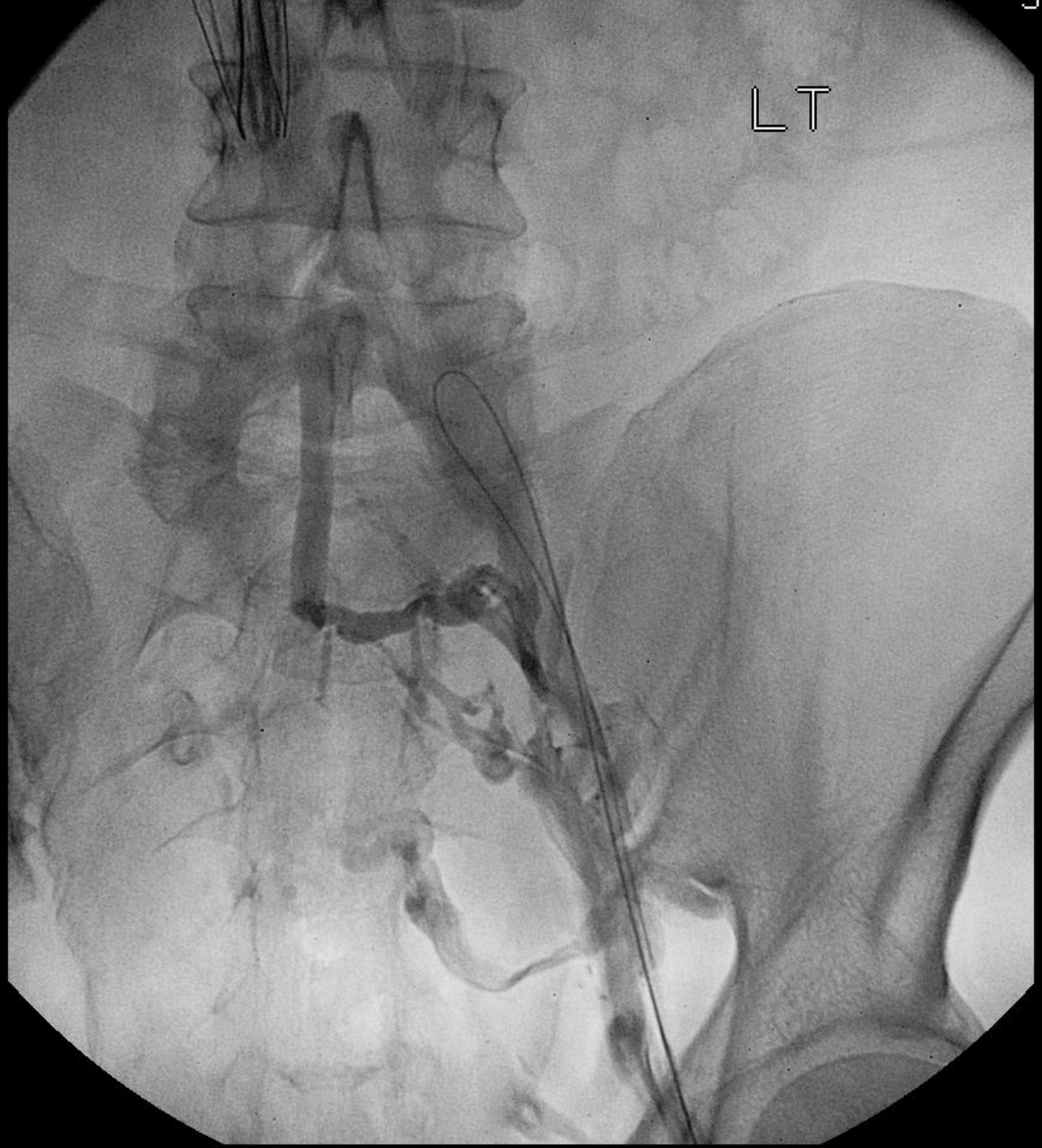
Post Valvuloplasty



valvuloplasty is a complex and demanding procedure. It gave good results but became obsolete because of the following landmark paper

- **Unexpected Major Role for Venous Stenting in Deep Reflux Disease:**
  Symptom Relief with Partial Correction of Pathology.
  Raju S, Darcey RL, Neglén P
  J Vasc Surg 51: 401-408; 2010.

- We stented iliac vein obstruction in combined obstruction/reflux in 528 limbs with plans for reflux repair later.
- Clinical relief from initial stenting was unexpectedly good and correction of the remaining reflux was not necessary.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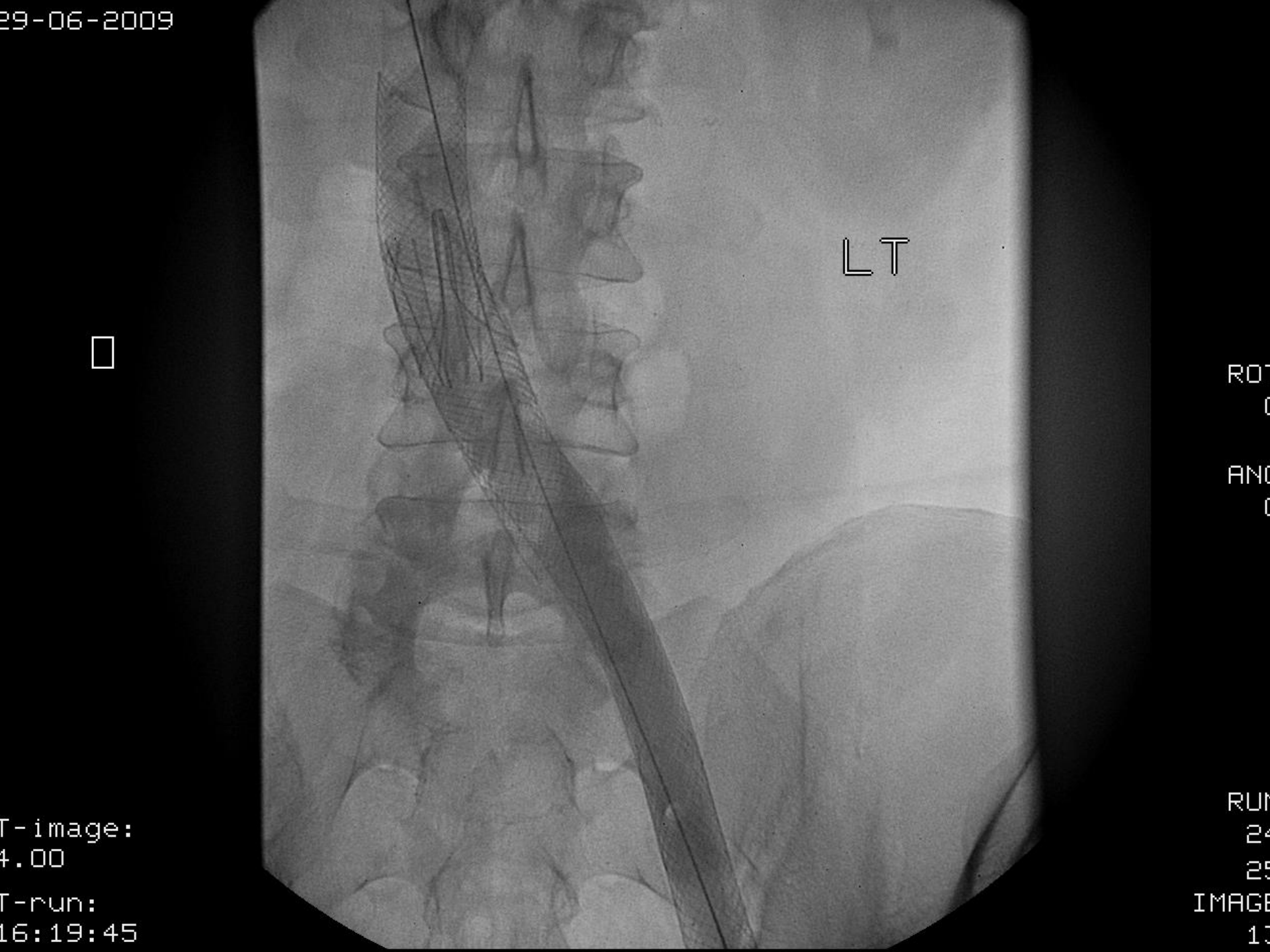
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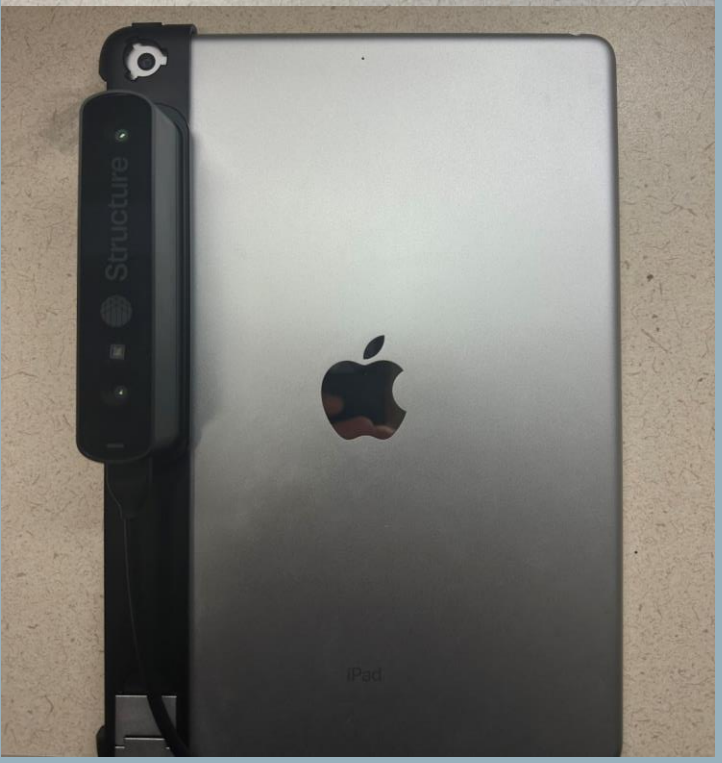
Quantifying Edema

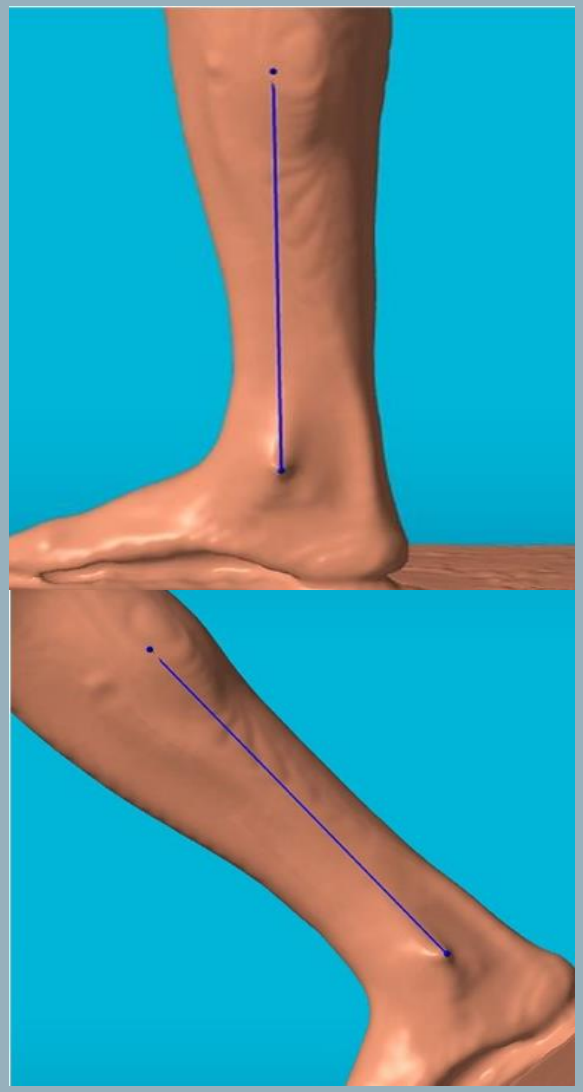
- Assessment of edema has been empirical and difficult to quantify.
- *VCSS* grades edema according to the time of day it reaches maximum. Many clinicians try to go a step further describing it variously as “pitting”, “ankle edema”, or “gross” if it involves the entire limb.
- Tape measurements of the limb are widely used but are imprecise at best.
- Water plethysmography is precise but impractical for routine clinical use. Volume surrogates such as electrical impedance may be precise but do not yield edema volume directly.
- Sophisticated 3D measurements with laser are available but expensive.



iPad Based Edema Meter

- Inexpensive 3D scanner and software.
- Widely available commercially from several vendors.
- Hardware specific protocol is easily developed for limb volumetry.

- The distance between the scanner and the limb should be three feet or less. (we use a Hoola-hoop) to minimize zoom error.



- The target for 3D measurement is a 25 cm long leg volume, starting at the medial malleolus. This is electronically marked by a line between two dots as shown here.
- Limb tilt does not affect the result.

Volume Variance as Measured by Two Different Technicians on the Same Subject Limb.

Subject	Scan Side	Technician 1	Technician 2
1	R	1535	1517
	L	1526	1564
2	R	1528	1544
	L	1631	1619
3	R	1866	1841
	L	1775	1800
4	R	1795	1828
	L	1738	1774
5	R	1950	1939
	L	1993	1942
6	R	1718	1754
	L	1761	1722
7	R	2066	2104
	L	2023	2068
8	R	1513	1552
	L	1595	1640
9	R	1971	1962
	L	2023	1958
10	R	2275	2196
	L	2333	2319
Mean Volume Difference ± SD		2.6% ± 1.5	1.8% ± 0.9

The
End

Conclusions

- An iPad-based 3D scanner can be used for routine limb volumetry in the clinic
- The equipment and software are widely available and inexpensive. The measurement method is simple and quick (15 minutes) amenable for routine clinical use.
- Volumetric data obtained by this method cannot be validated by external comparison by another method because the target limb volume cannot be precisely duplicated between methods.
- However, internal validation has been established by comparison of results between different technicians. It yields low variance and low standard error.

Leg swelling in old ladies is often neglected. NIVL or PTS lesions are often present. Leg swelling retards mobility and self care. Bilateral lesions occur in ≈20%

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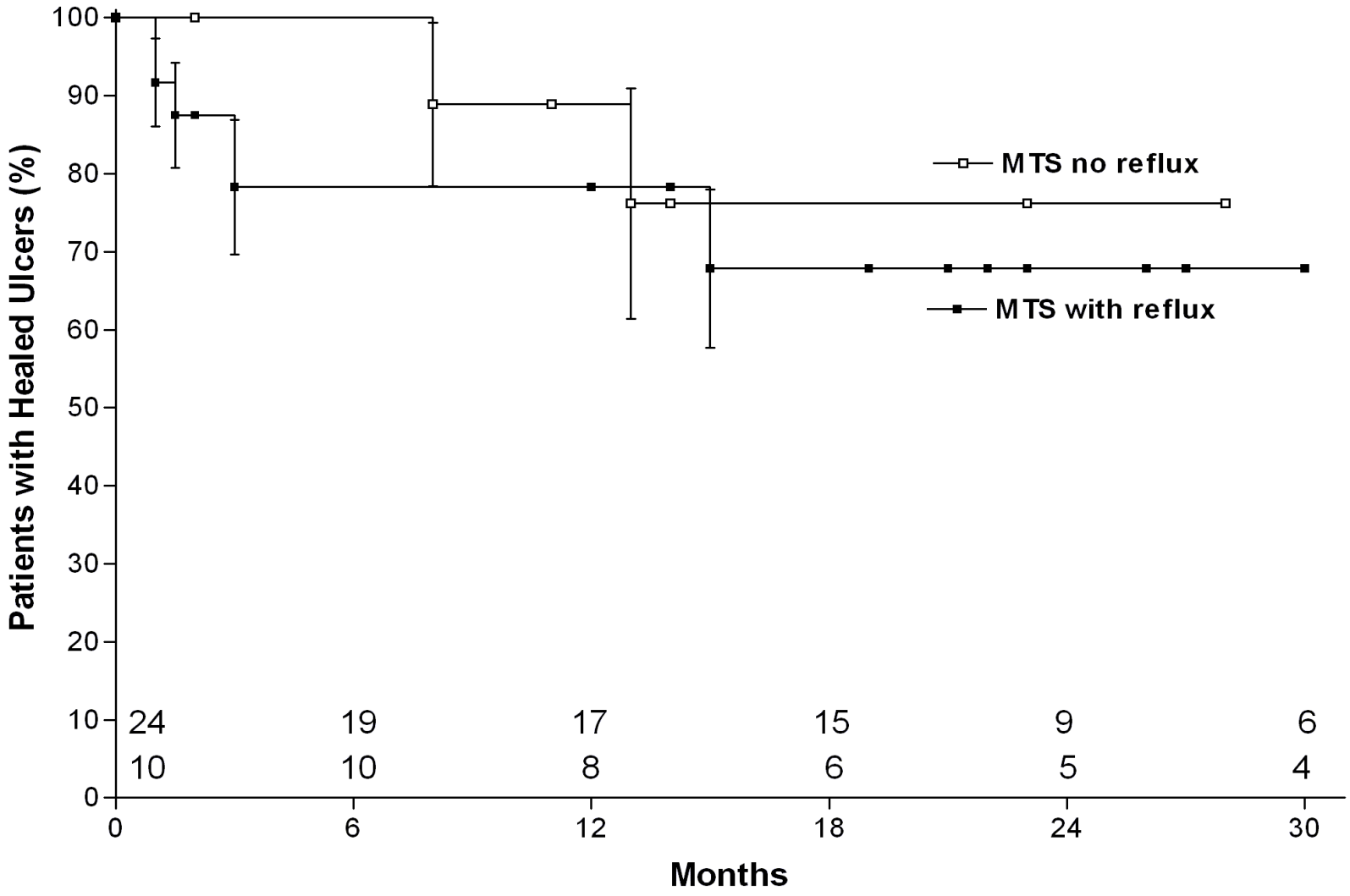
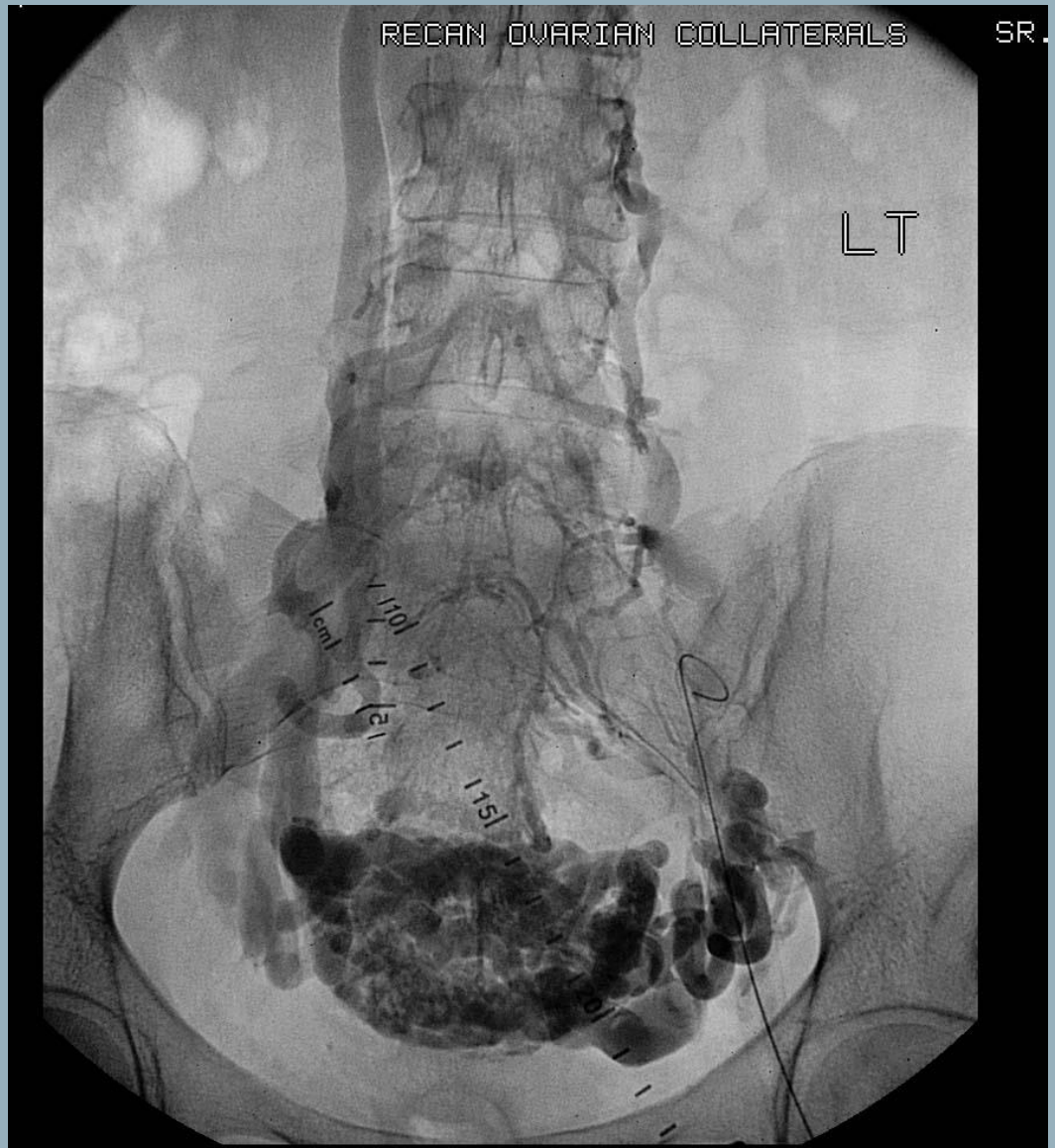
Indications for ivus

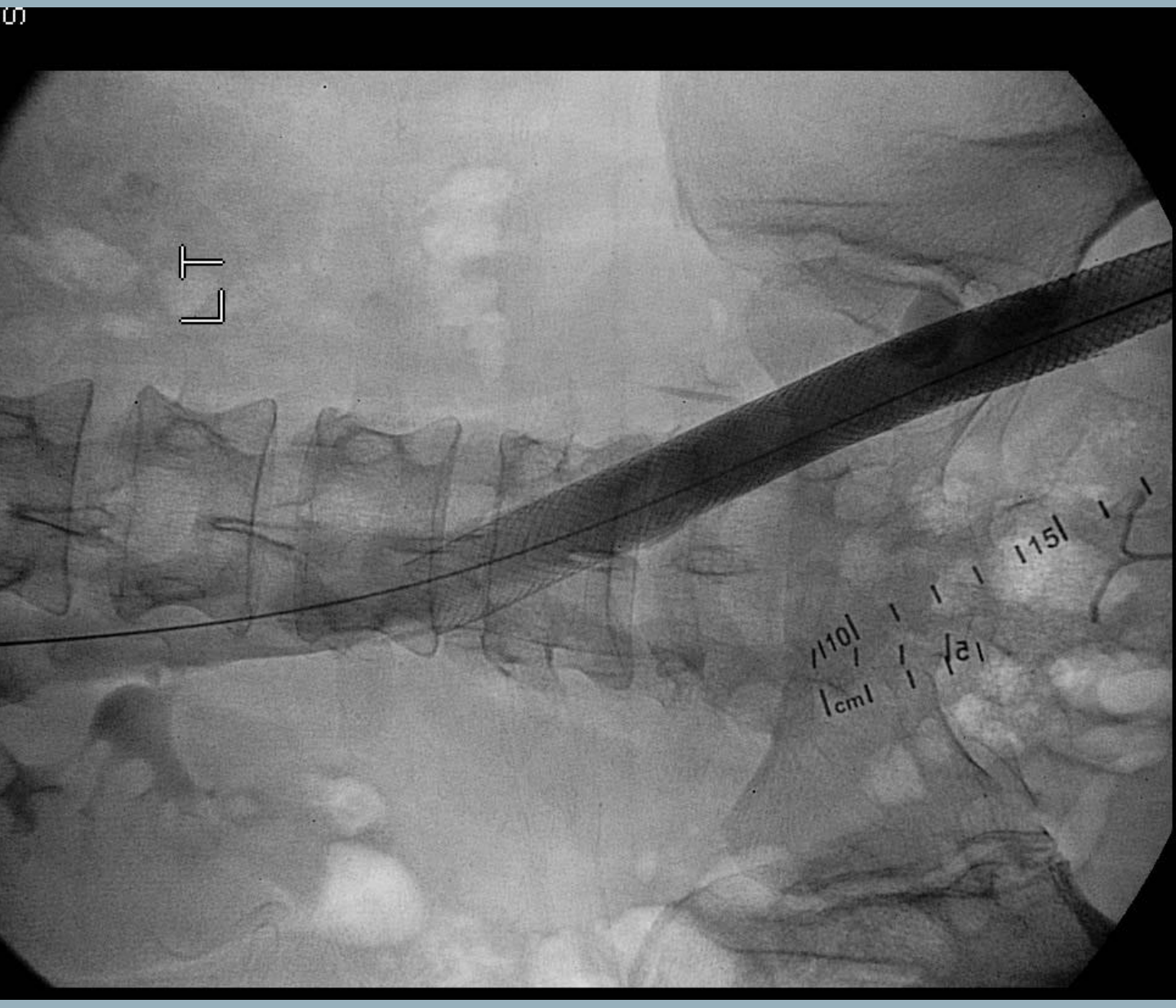
What is a permissive lesion

- Examples


Patients with Healed Ulcers (%)
100
90
80
70
60
50
40
30
20
10
0
MTS no reflux
MTS with reflux
24
19
17
15
9
6
10
10
8
6
5
4
0
6
12
18
24
30
Months

Recannalization of CTO lesions:
About 80% procedure success and good long term patency.




15
10
cm

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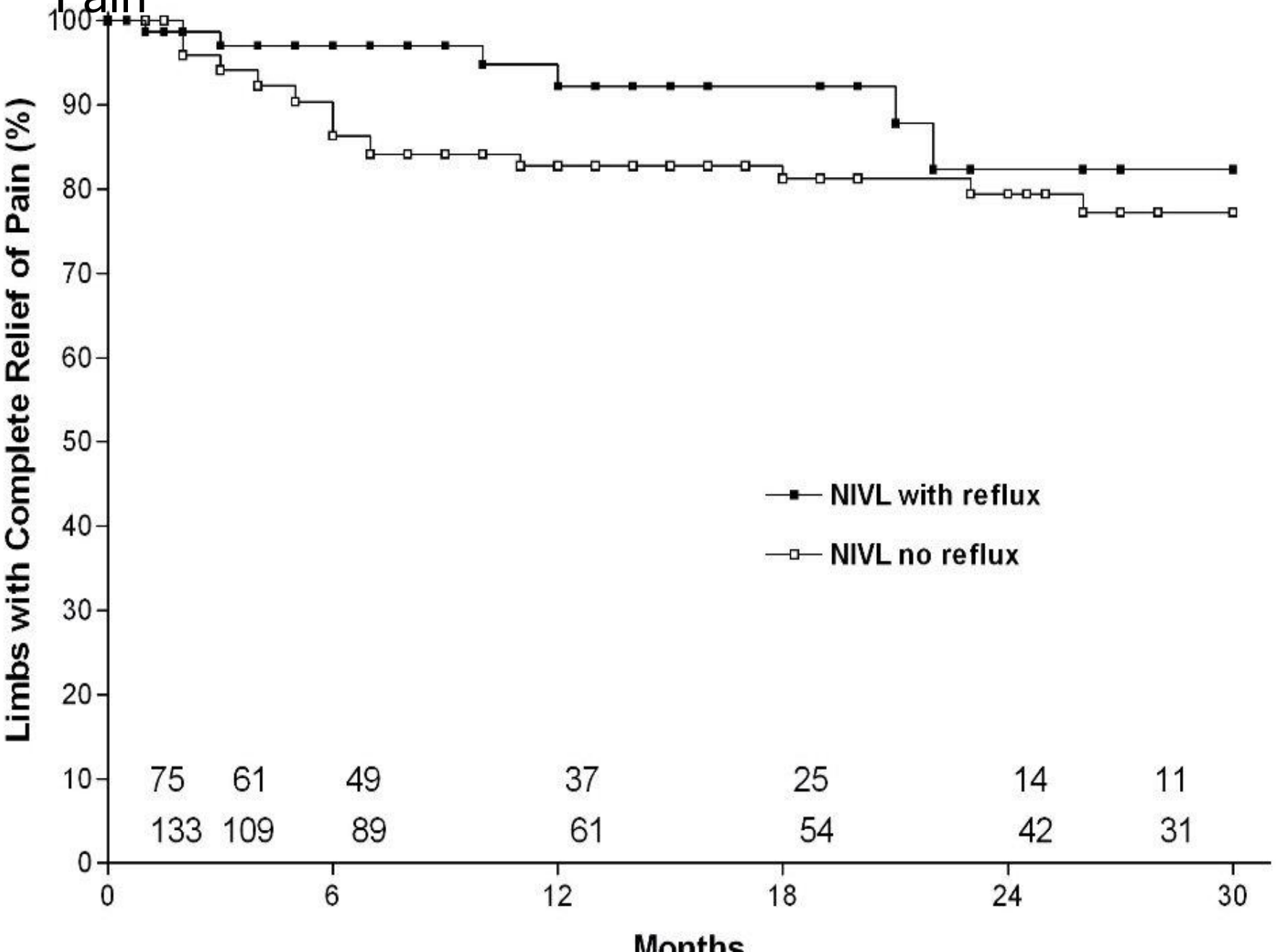
High prevalence of nonthrombotic iliac vein lesions in chronic venous disease: A permissive role in pathogenicity

Seshadri Raju, MD, and **Peter Neglen, MD, PhD,** *Flowood, Miss*

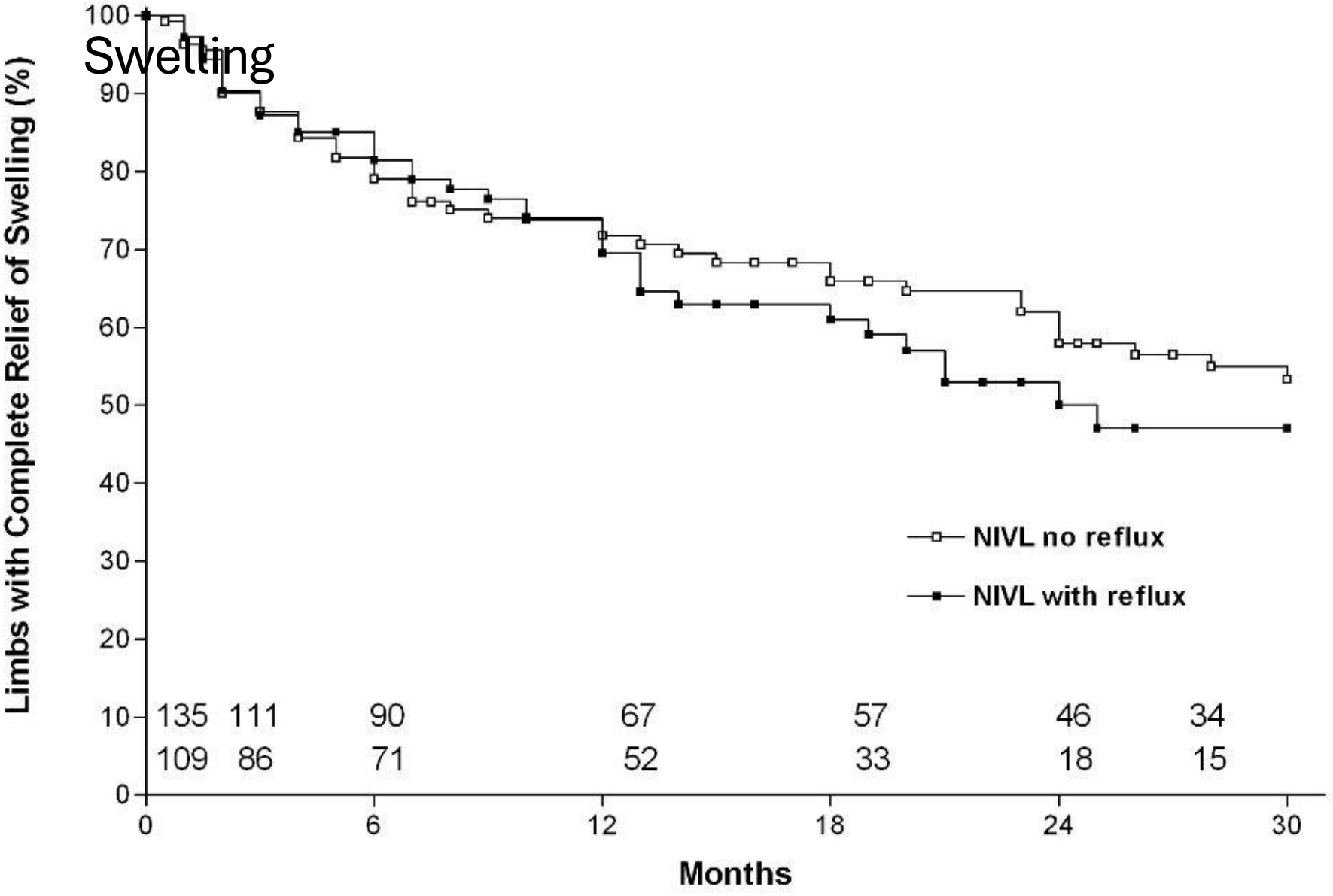
JVS July 2006

Purpose: **Nonthrombotic iliac vein lesions (NIVL), such as webs and spurs described by May and Thurner, are commonly found in the asymptomatic general population. However, the clinical syndrome, variously known as May-Thurner**

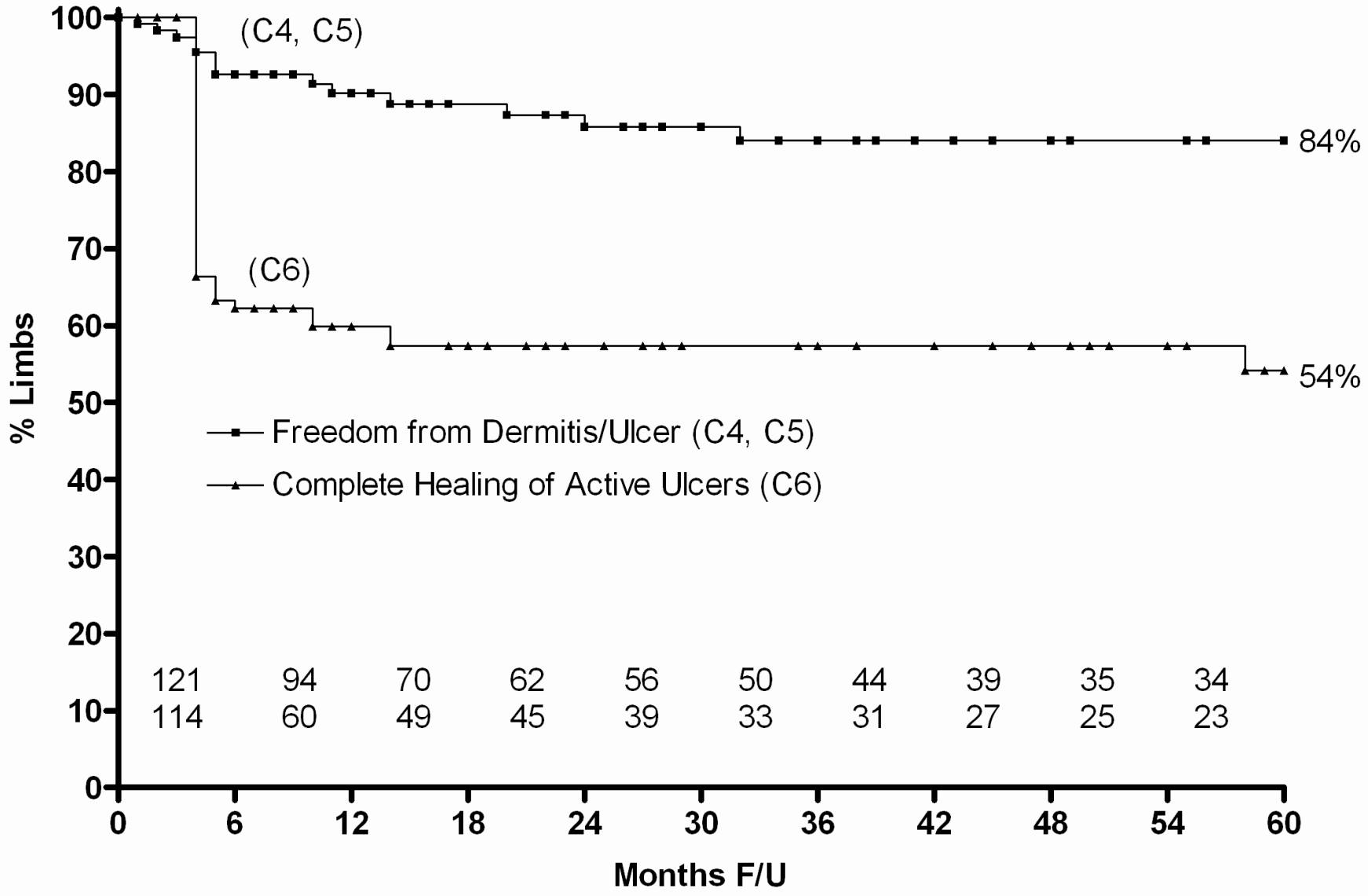
Pain

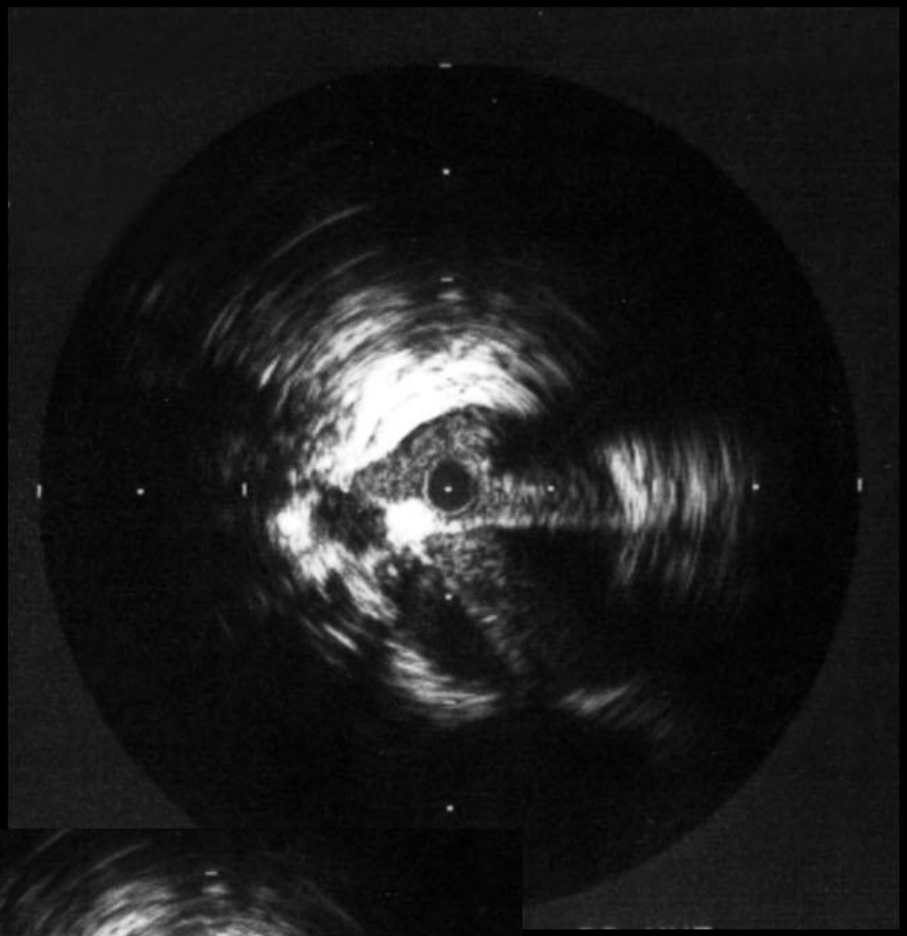

Limbs with Complete Relief of Pain (%)
100
90
80
70
60
50
40
30
20
10
0
NIVL with reflux
NIVL no reflux
75 61 49 37 25 14 11
133 109 89 61 54 42 31
0 6 12 18 24 30
Months

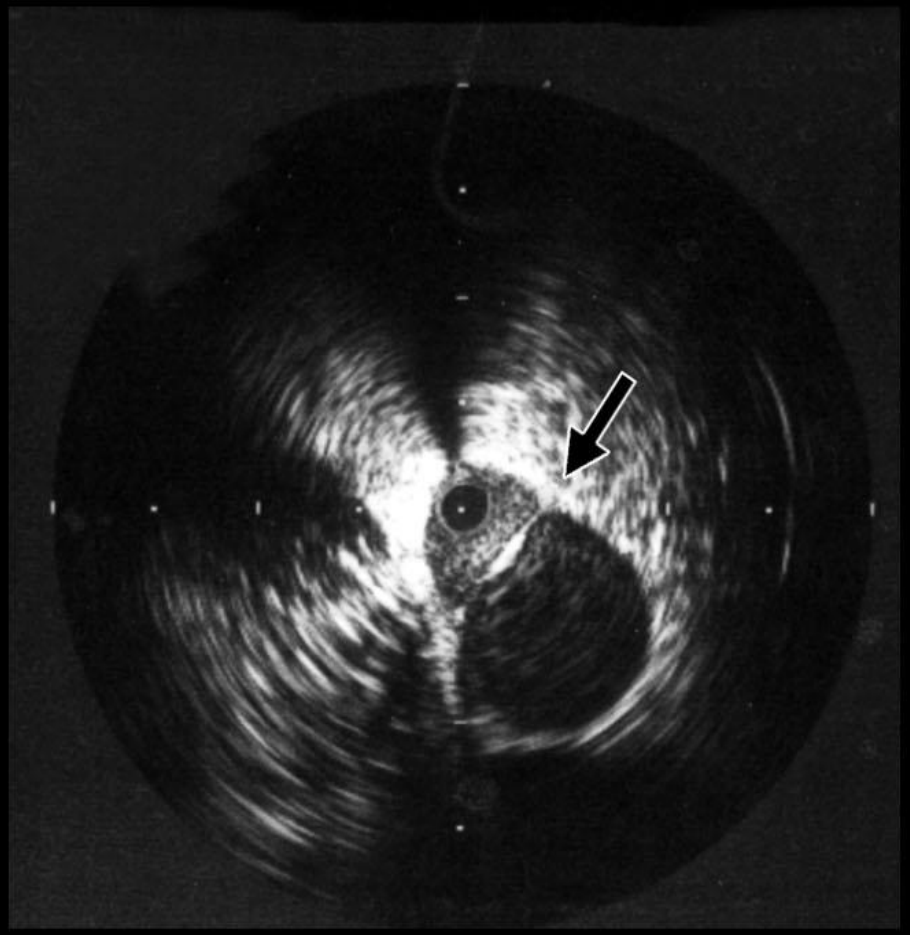
Swelling

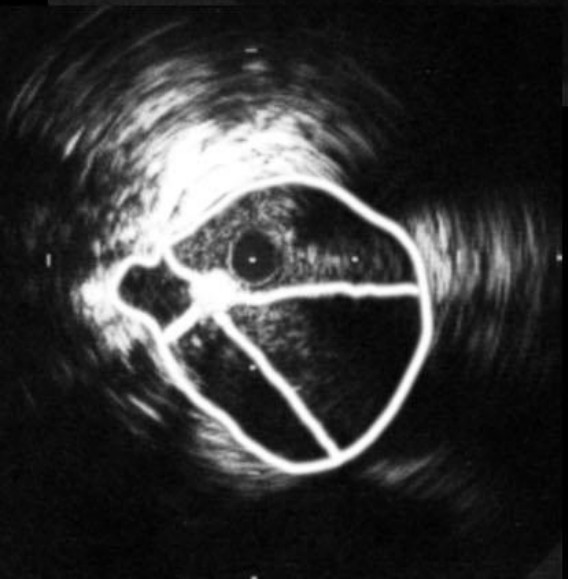

Limbs with Complete Relief of Swelling (%)
100
90
80
70
60
50
40
30
20
10
0
NIVL no reflux
NIVL with reflux
135 111 90 67 57 46 34
109 86 71 52 33 18 15
0 6 12 18 24 30
Months

CUMULATIVE HEALING OF DERMATITIS/ULCER AND FREEDOM FROM RECURRENCE

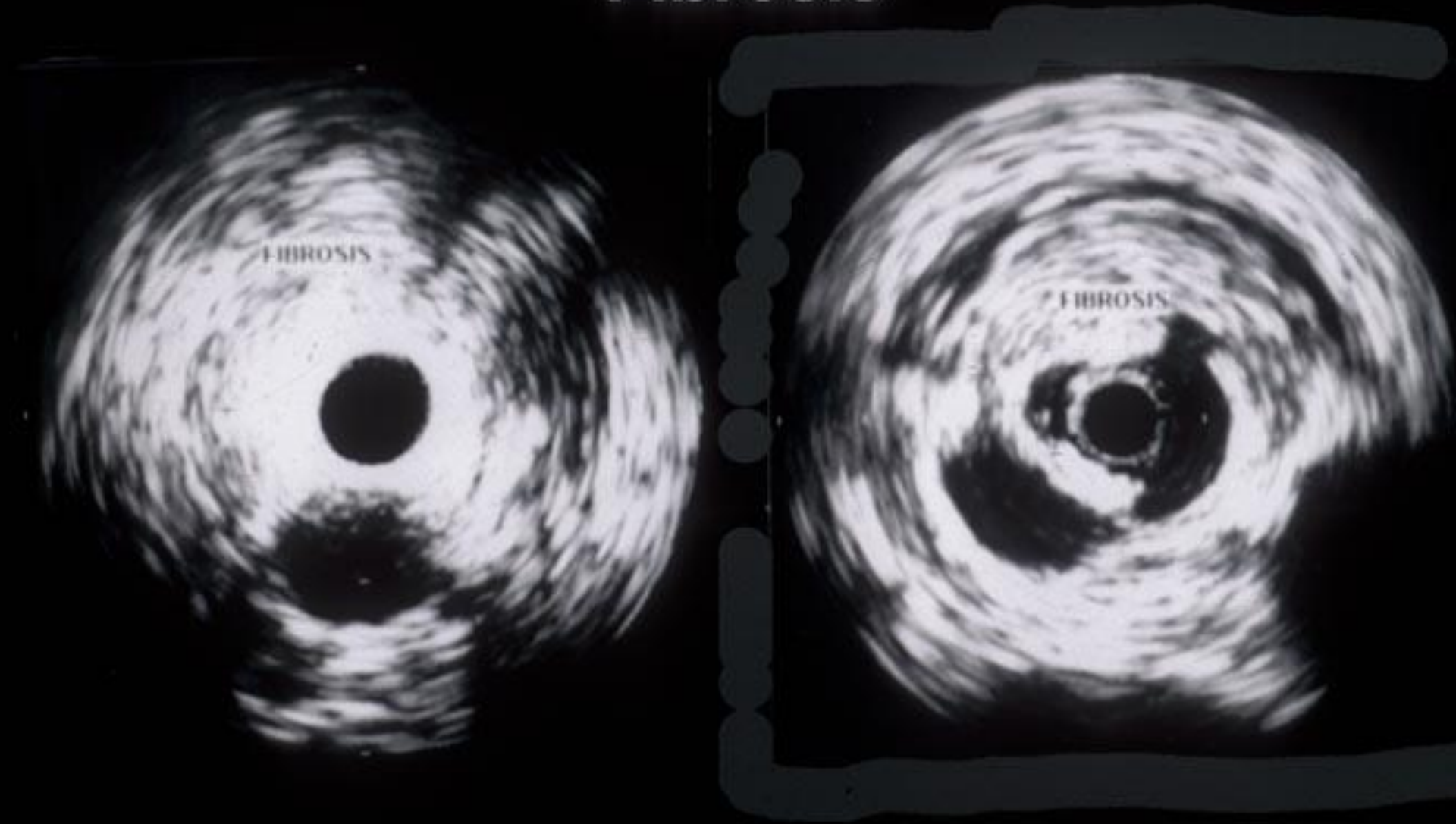


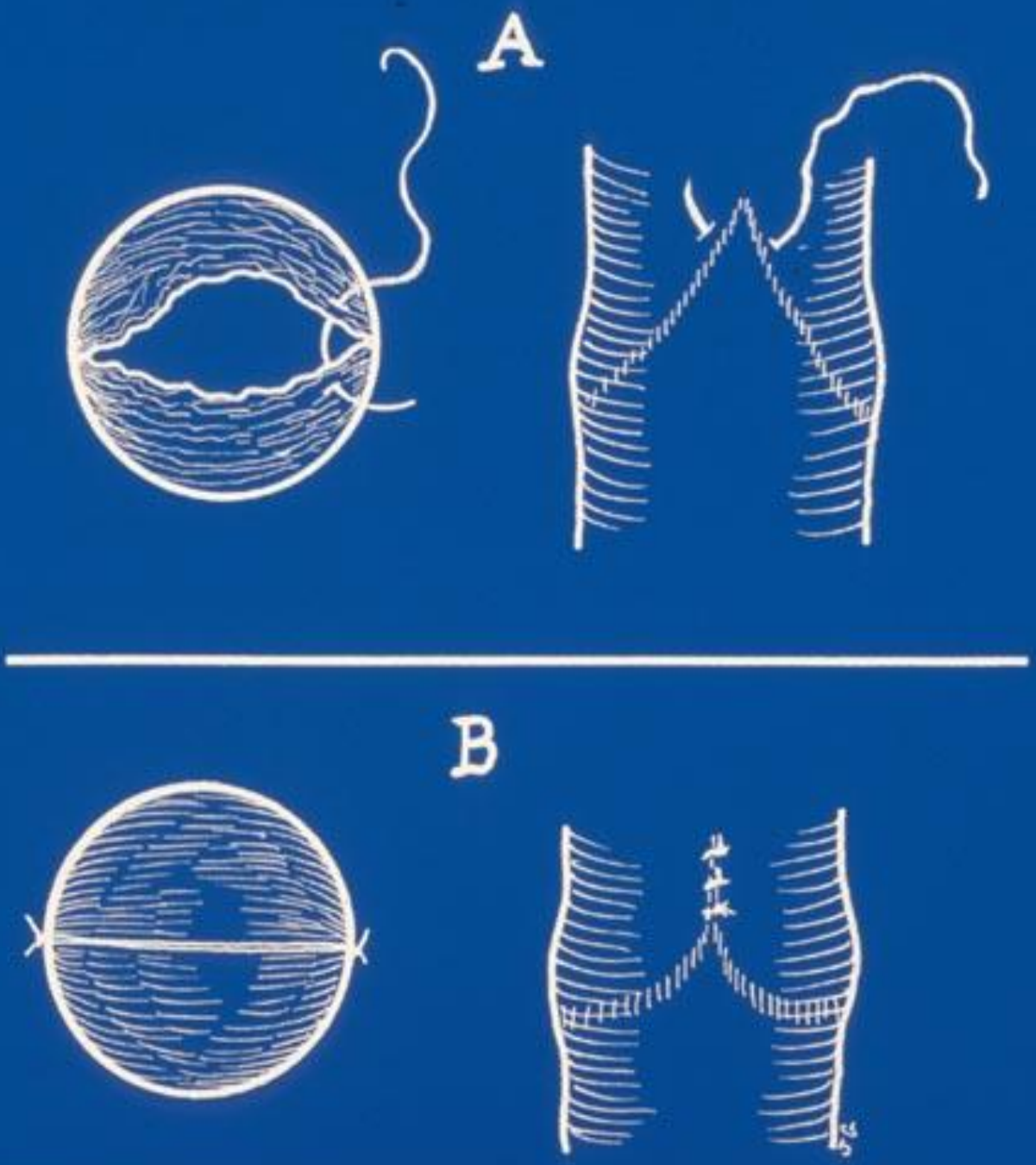


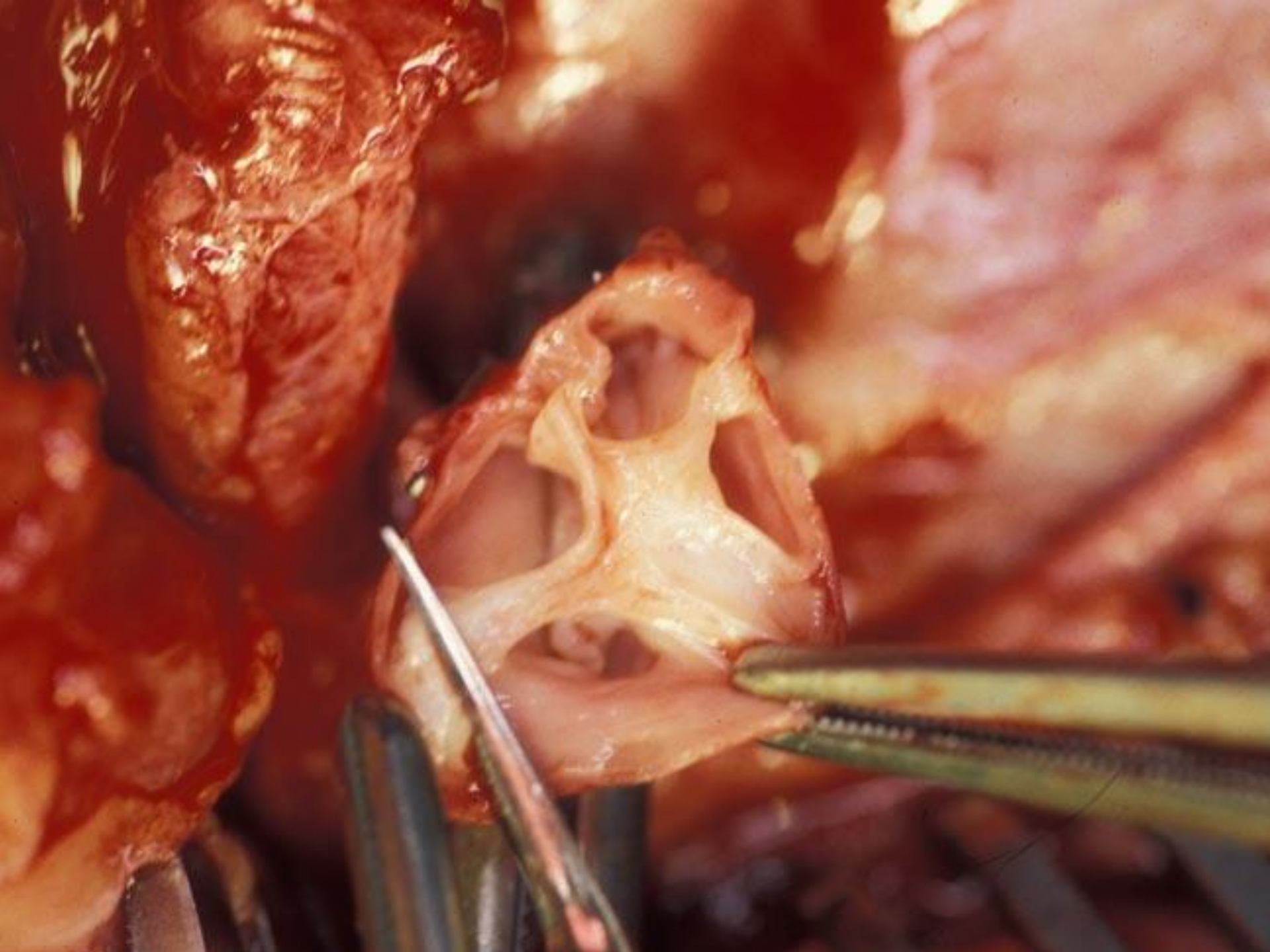


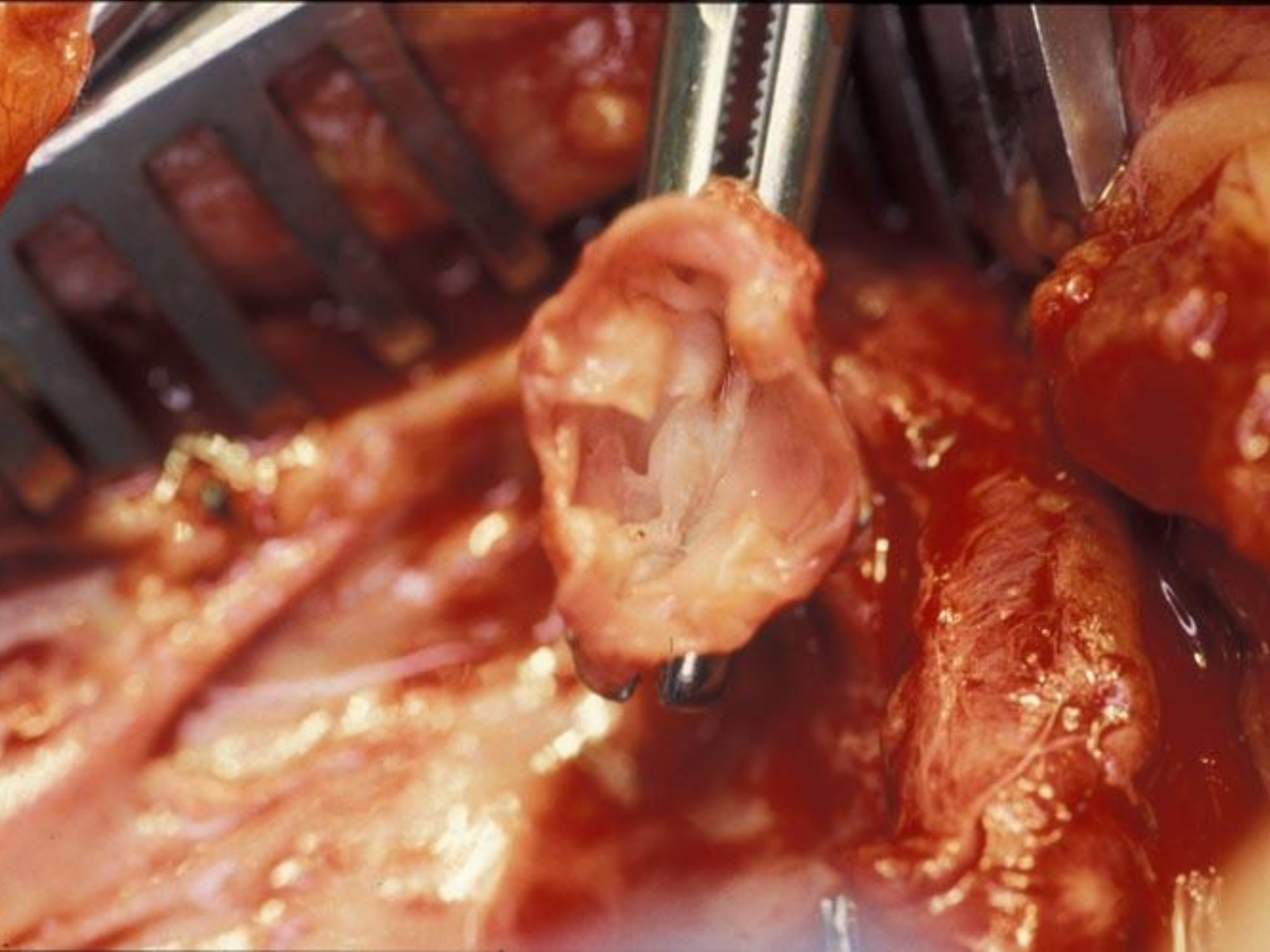


"Fibrosis"




A
B





Stent Outcome is good even if reflux is present and uncorrected

n=528 Limbs

Reflux Distribution

Deep Reflux only	**32%**
Deep and Suprfl	**68%**
Perforator	**21%***

***(all with Deep or D/S Reflux)**

Axial Reflux 42%

Reflux Segmnt Score**

Mean 2.9 ± 1.5

****1 each for Fem, Prof, Pop, Prox GSV, Distal GSV, SSV and Perf.**

Maximum Possible 7

Reflux segment Score of ≥3 in 58%

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From the Society for Vascular Surgery

Unexpected major role for venous stenting in deep reflux disease

JVS February 2010

Seshadri Raju, MD,[a] **Rikki Darcey, BS,**[b] and **Peter Neglén, MD, PhD,**[b] *Jackson and Flowood, Miss*