

COME METTO LA SONDA? L'ESSENZIALE PER INIZIARE L'ECO VASCOLARE  
ARTI INFERIORI

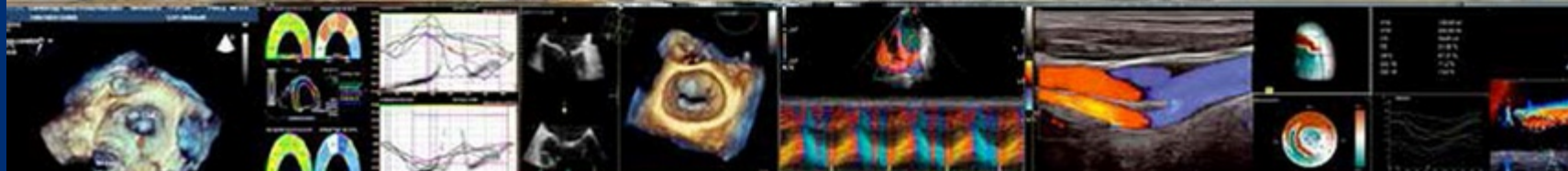
Dr Fortunato Arenga

# ECOCARDIOGRAFIA 2015

## XVII Congresso Nazionale SIEC

Hotel Royal Continental

Napoli, 16-18 Aprile 2015



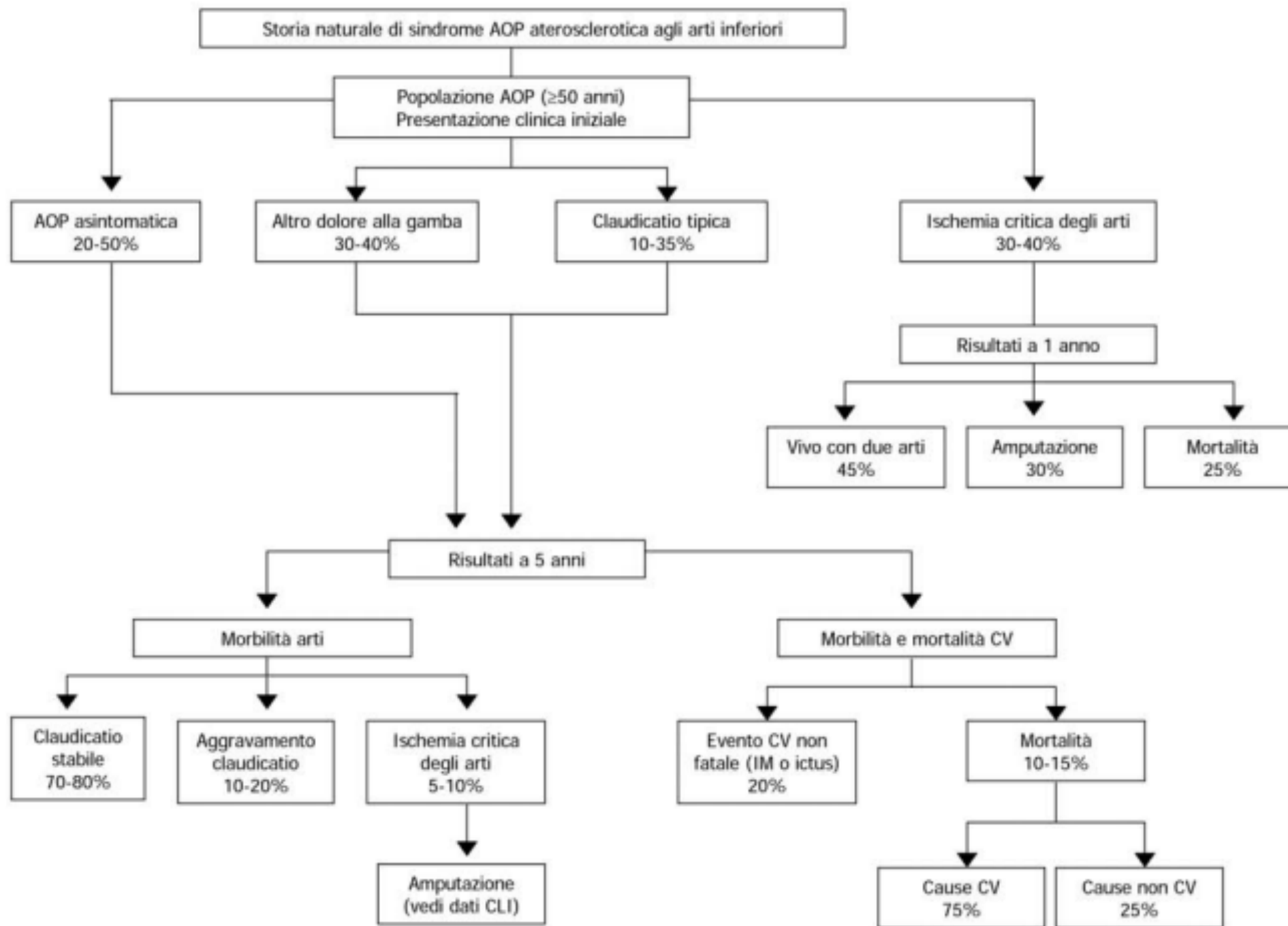
Perché abitualmente nel laboratorio di ecocardiografia NON eseguiamo routinariamente l'ecocolor doppler degli arti inferiori?

# Le dimensioni di un problema

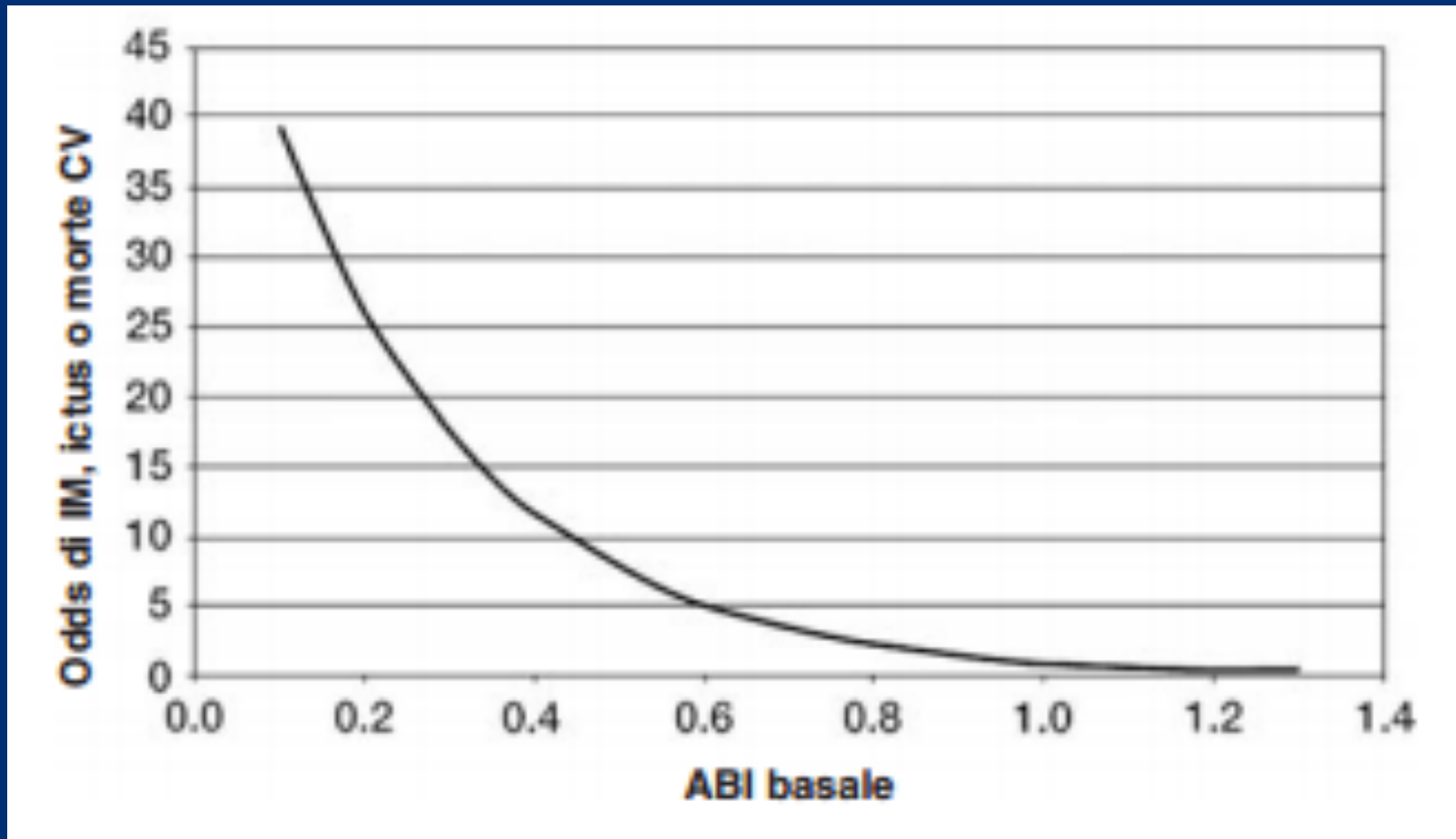
- La **prevalenza totale** della malattia basata su test oggettivi, valutata in diversi studi epidemiologici, ha un range dal 3 al 10%, incrementandosi al **15-20%** nei soggetti con più di 70 anni
- Per ogni paziente con AOP sintomatica ci sono da 3 a 4 soggetti con AOP che non soddisfano i criteri clinici per CI.

The high prevalence of combined CAD and PVD has been confirmed in two large international studies—the REACH (Reduction in Atherothrombosis for Continued Health) registry and the AGATHA (A Global Atherothrombosis Assessment) study in which 16–35% of patients (with established atherosclerotic disease or three or more risk factors) had polyvascular disease.

Significant CAD in at least one vessel has been reported in ~60% of patients with severe lower extremity PVD requiring surgery

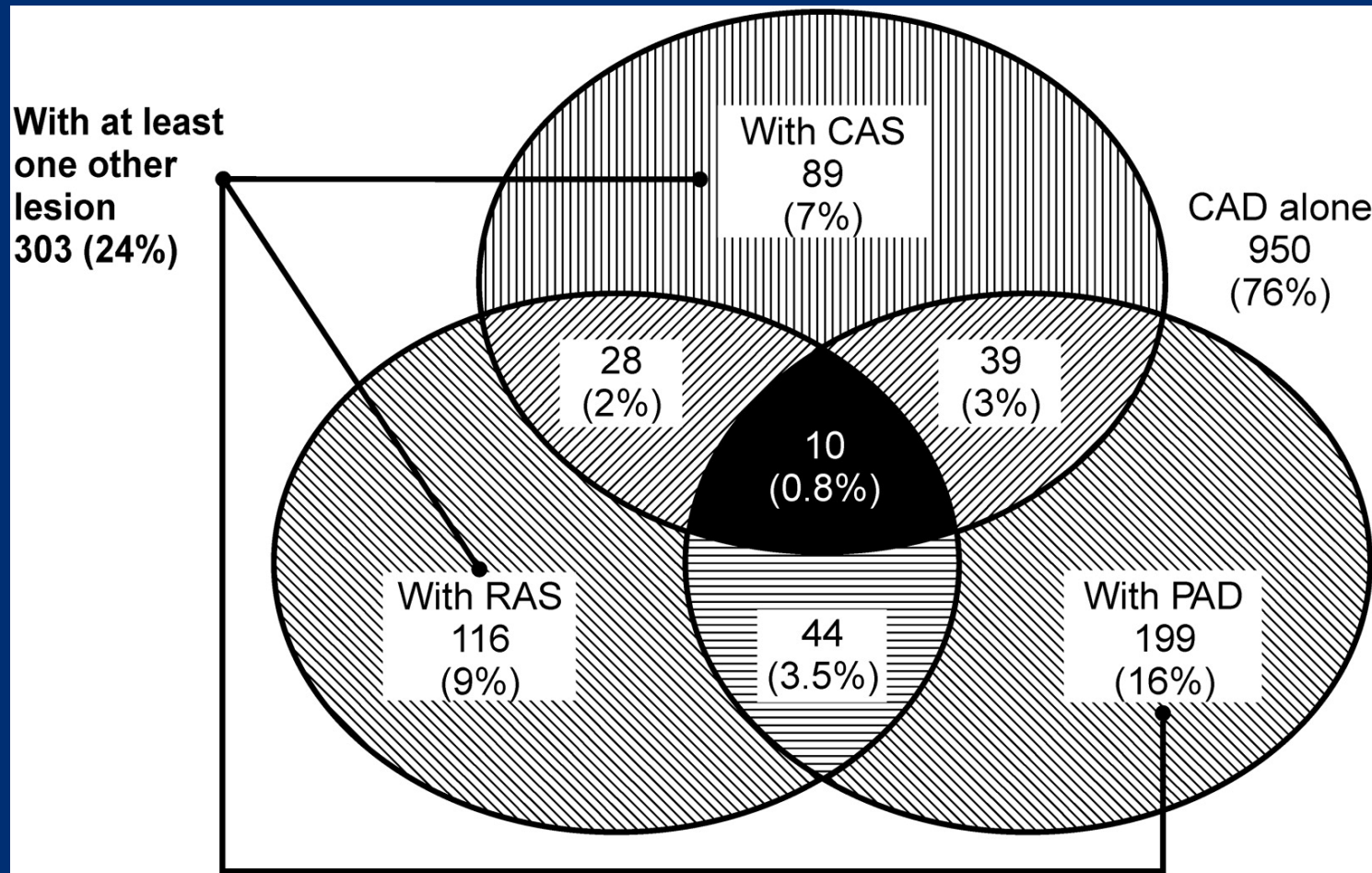


## TASC II Documento di Consenso InterSocietario TransAtlantico per il trattamento dell'arteriopatia periferica



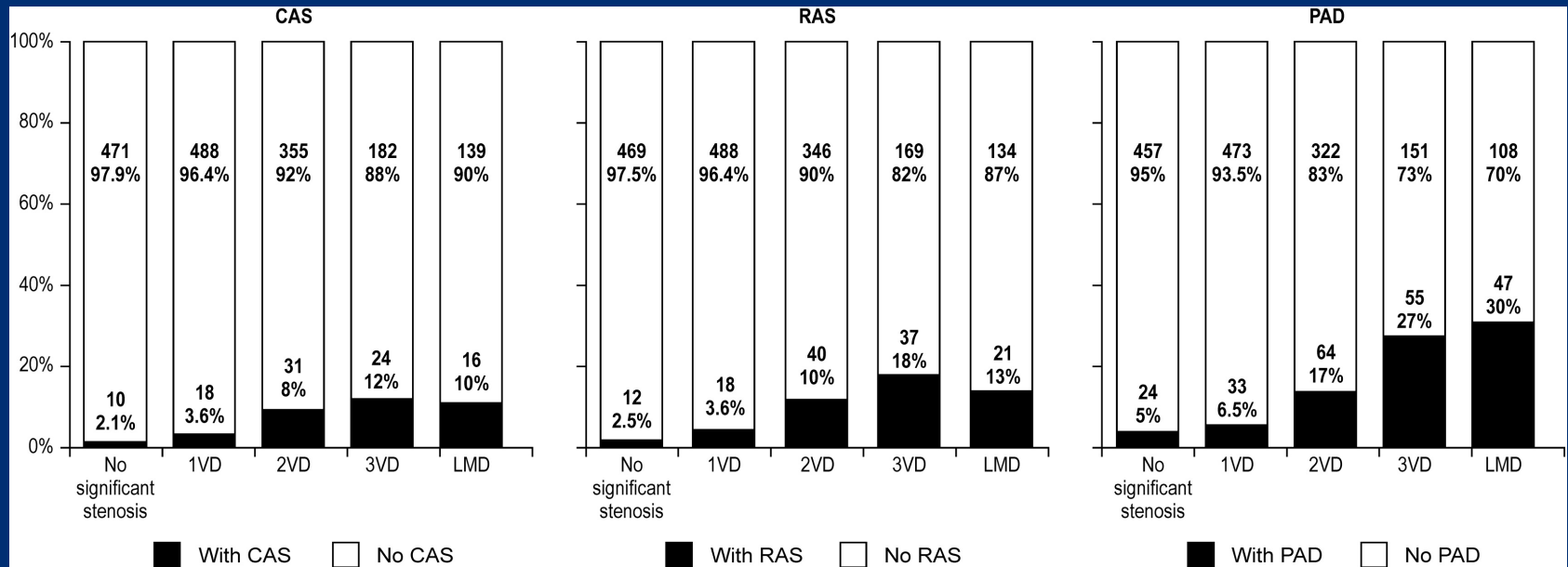
# Co-Existence of Carotid Artery Disease, Renal Artery Stenosis, and Lower Extremity Peripheral Arterial Disease in Patients With Coronary Artery Disease

Yoichi Imori, MD, Takeshi Akasaka, MD, PhD, Tomoki Ochiai, MD, Kazuma Oyama, MD, Kazuki Tobita, MD, Koki Shishido, MD, Yu Nomura, MD, Futoshi Yamanaka, MD, Kazuya Sugitatsu, MD, Nobuhiro Okamura, MD, Shingo Mizuno, MD, Ken Arima, MD, Hidetaka Suenaga, MD, Masato Murakami, MD, Yutaka Tanaka, MD, Junya Matsumi, MD, Saeko Takahashi, MD, Shinji Tanaka, MD, Satoshi Takeshita, MD, Shigeru Saito, MD



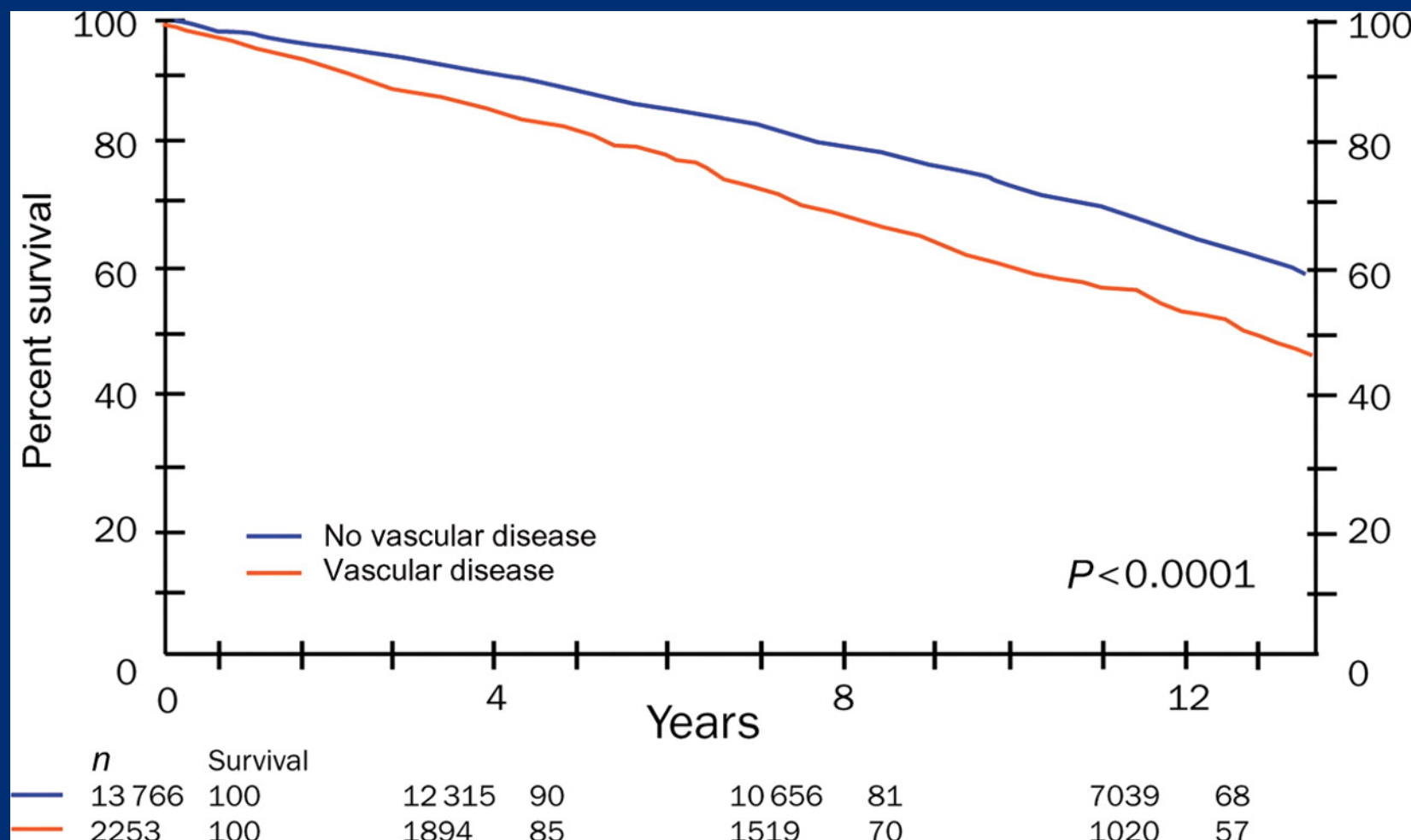
# Co-Existence of Carotid Artery Disease, Renal Artery Stenosis, and Lower Extremity Peripheral Arterial Disease in Patients With Coronary Artery Disease

Yoichi Imori, MD, Takeshi Akasaka, MD, PhD, Tomoki Ochiai, MD, Kazuma Oyama, MD, Kazuki Tobita, MD, Koki Shishido, MD, Yu Nomura, MD, Futoshi Yamanaka, MD, Kazuya Sugitatsu, MD, Nobuhiro Okamura, MD, Shingo Mizuno, MD, Ken Arima, MD, Hidetaka Suenaga, MD, Masato Murakami, MD, Yutaka Tanaka, MD, Junya Matsumi, MD, Saeko Takahashi, MD, Shinji Tanaka, MD, Satoshi Takeshita, MD, Shigeru Saito, MD



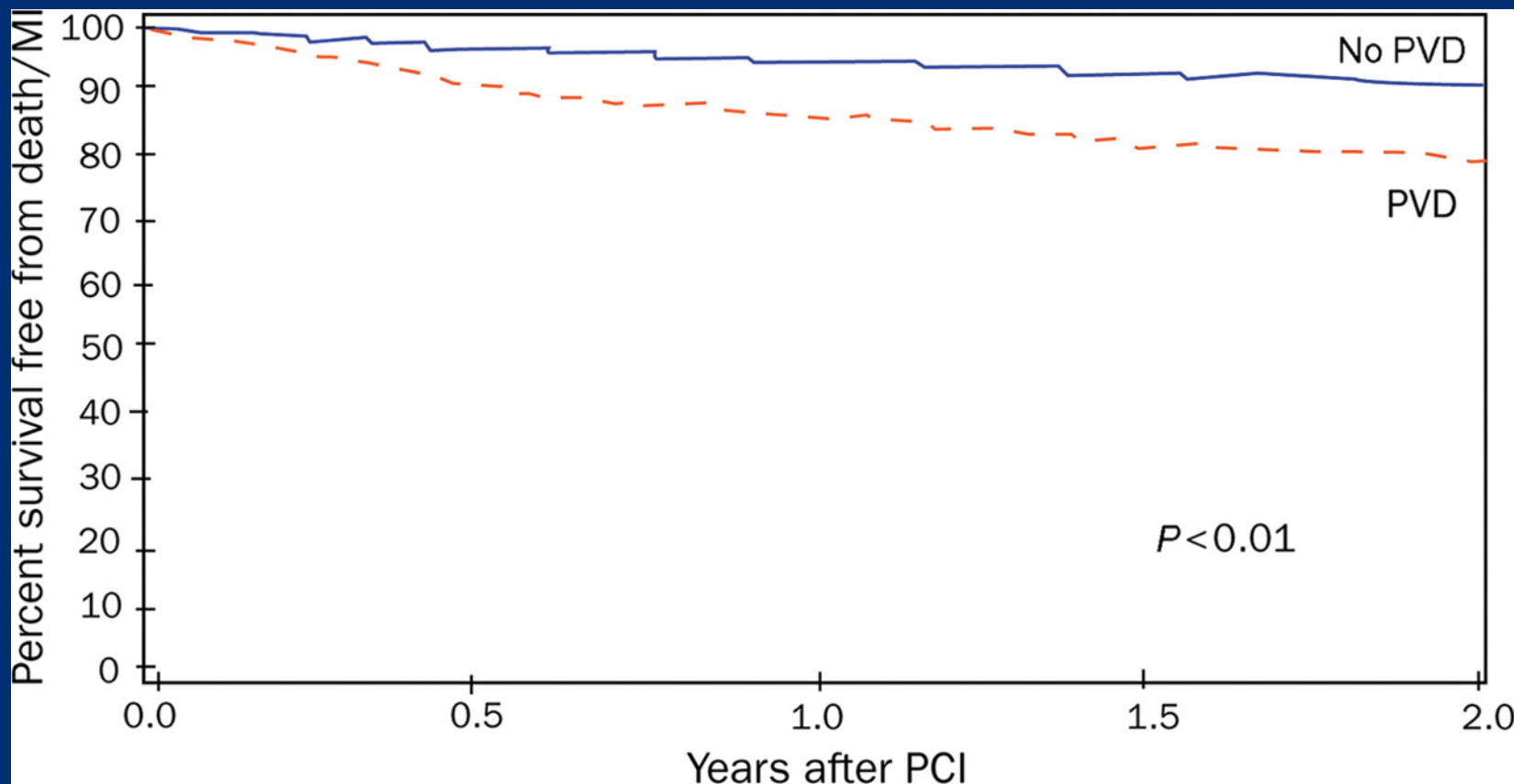
*American Journal of Cardiology* 2014 113, 30-35

## Kaplan–Meier survival curves in patients with and without vascular disease in the CASS study.



Andrew Cassar et al. Eur Heart J 2010;31:1565-1572

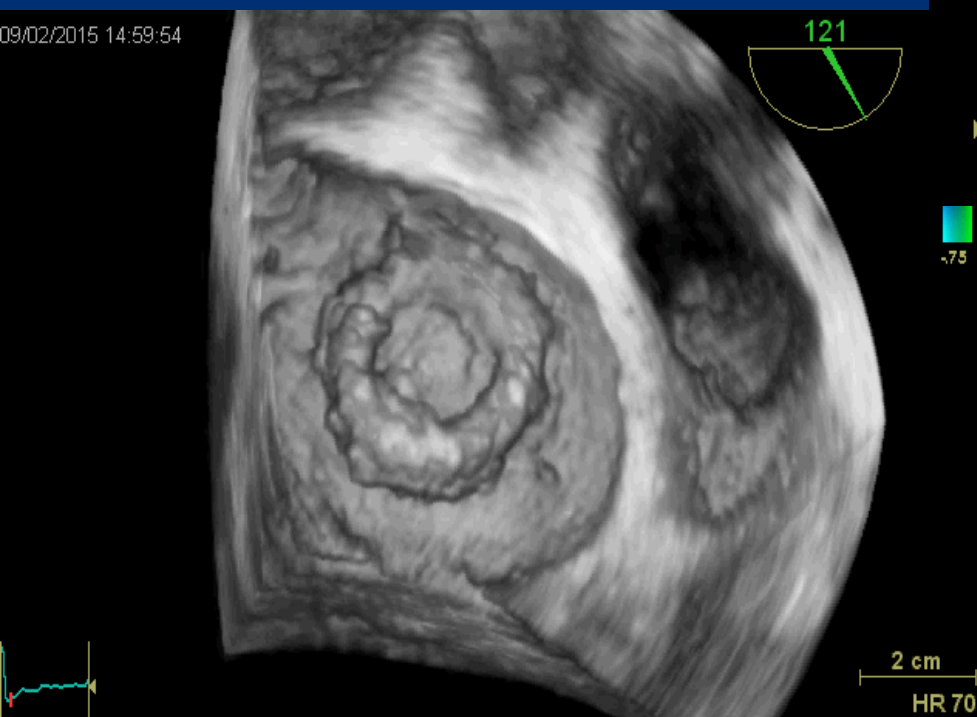
# Kaplan–Meier curves for survival free of death/myocardial infarction in patients with and without peripheral vascular disease (PVD) after percutaneous coronary interventions (PCI).



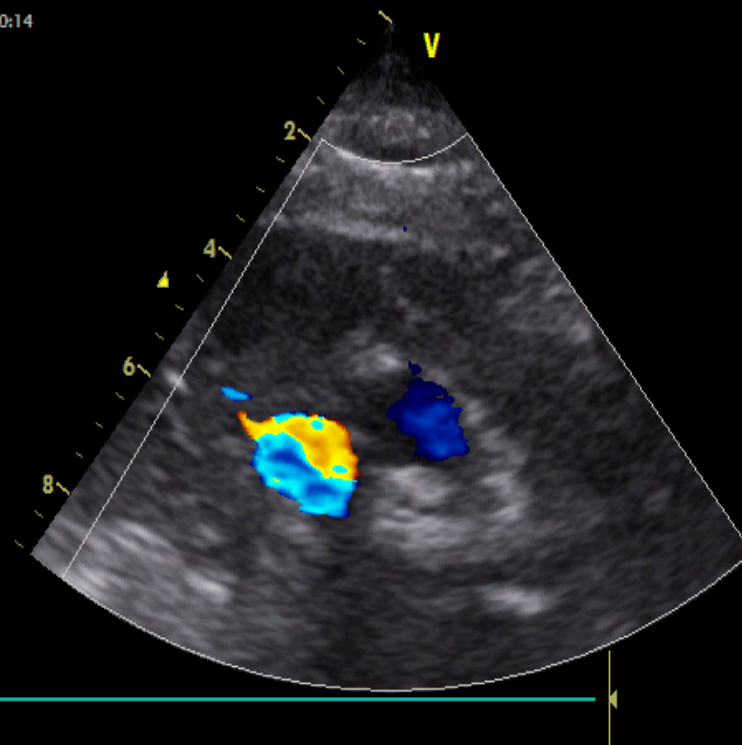
Andrew Cassar et al. Eur Heart J 2010;31:1565-1572

# Questione di imaging ?

09/02/2015 14:59:54

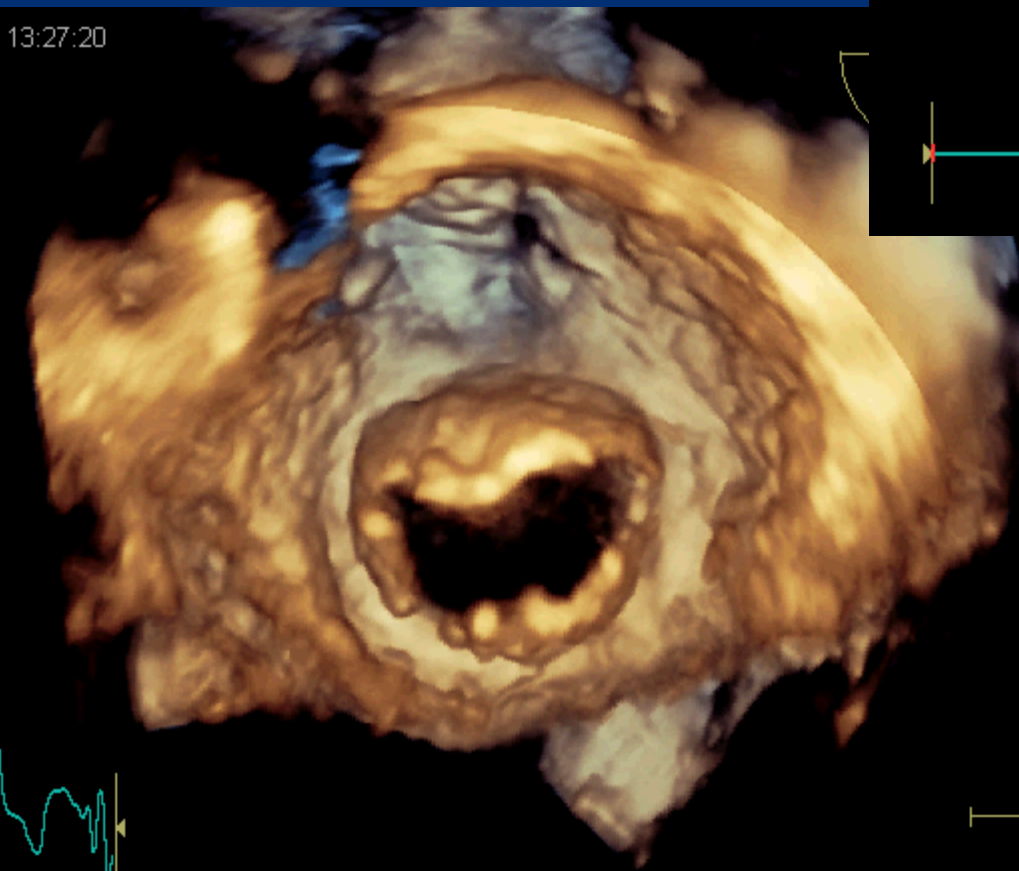


04/03/2015 23:00:14  
14

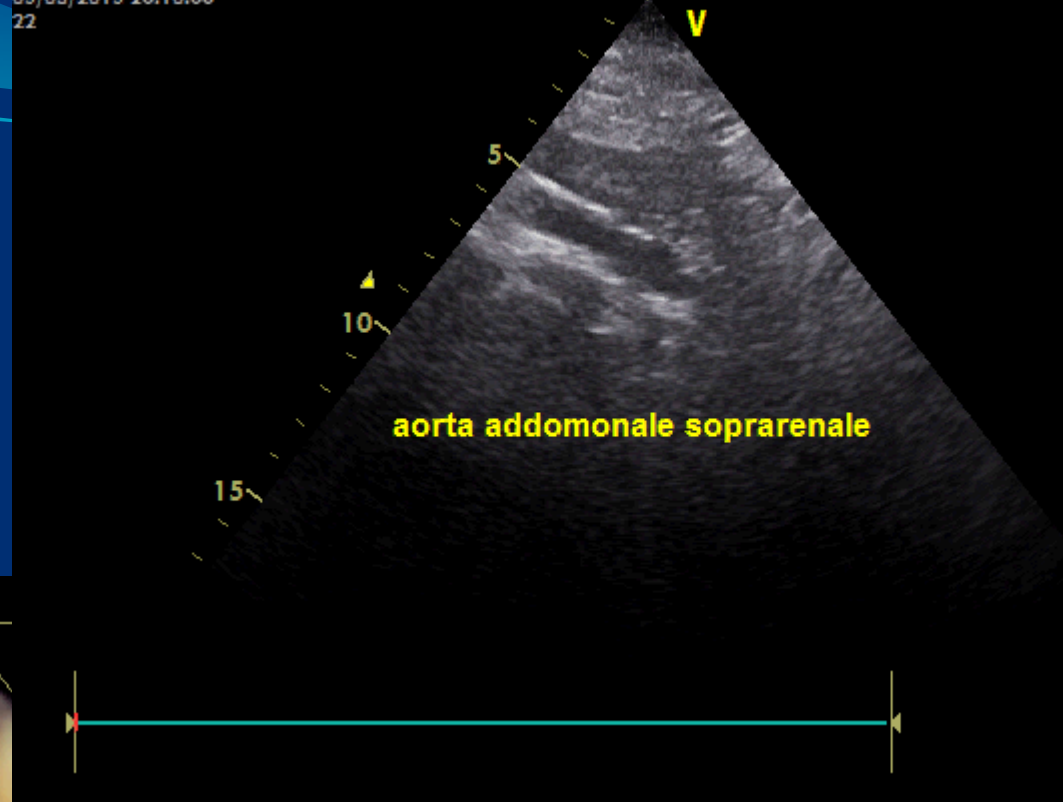


O .....?

13:27:20

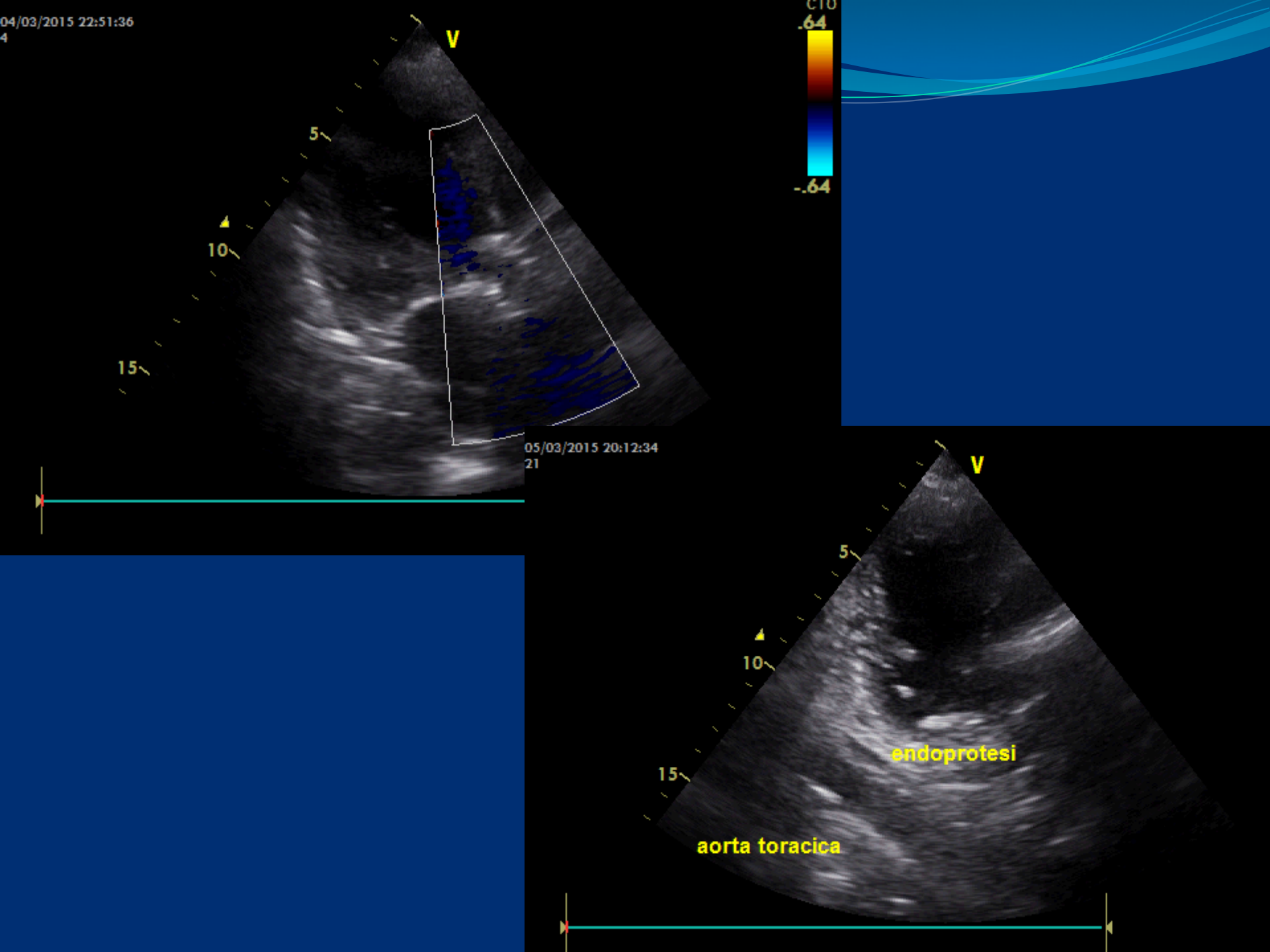


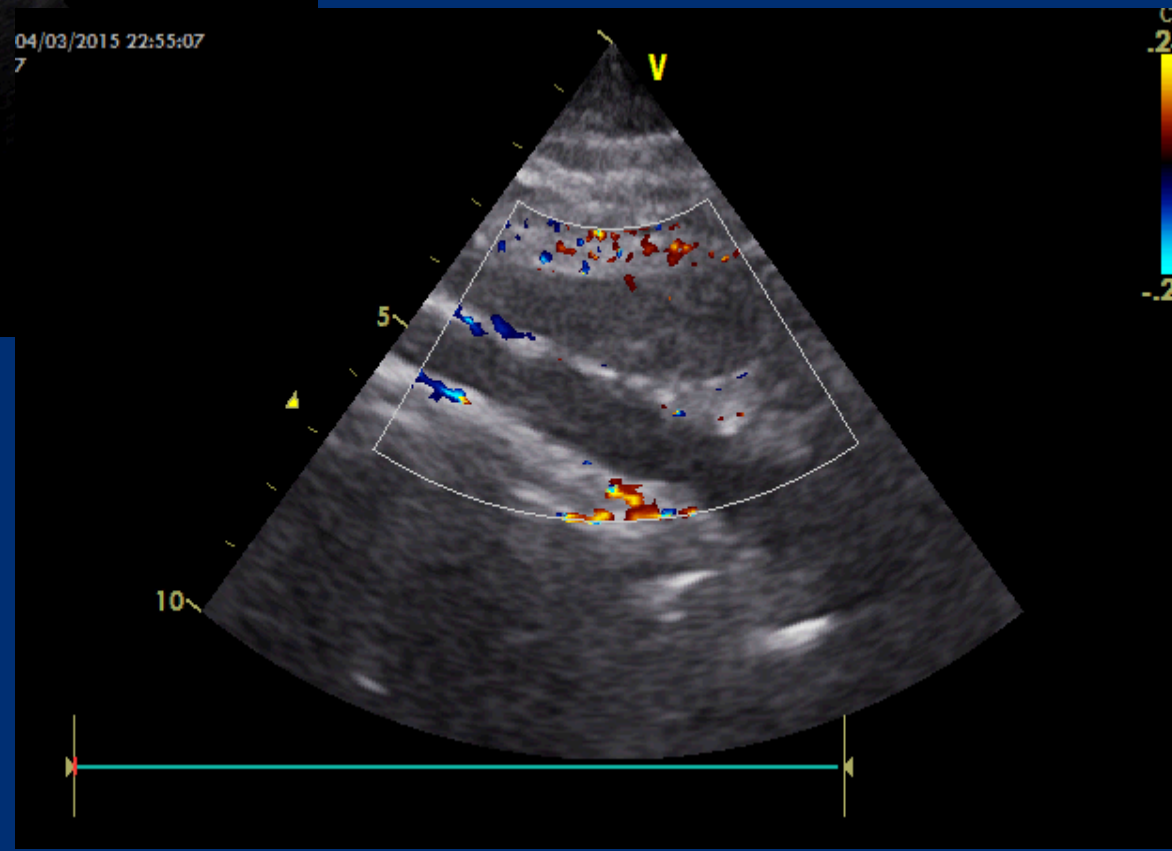
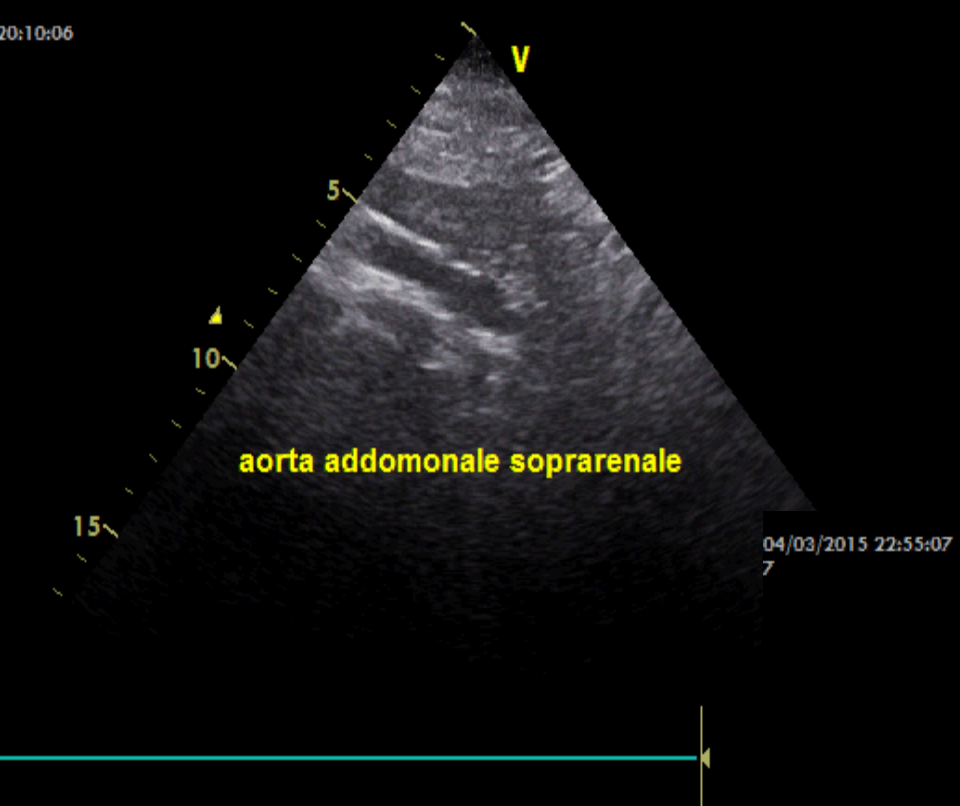
2 cm  
HR 80



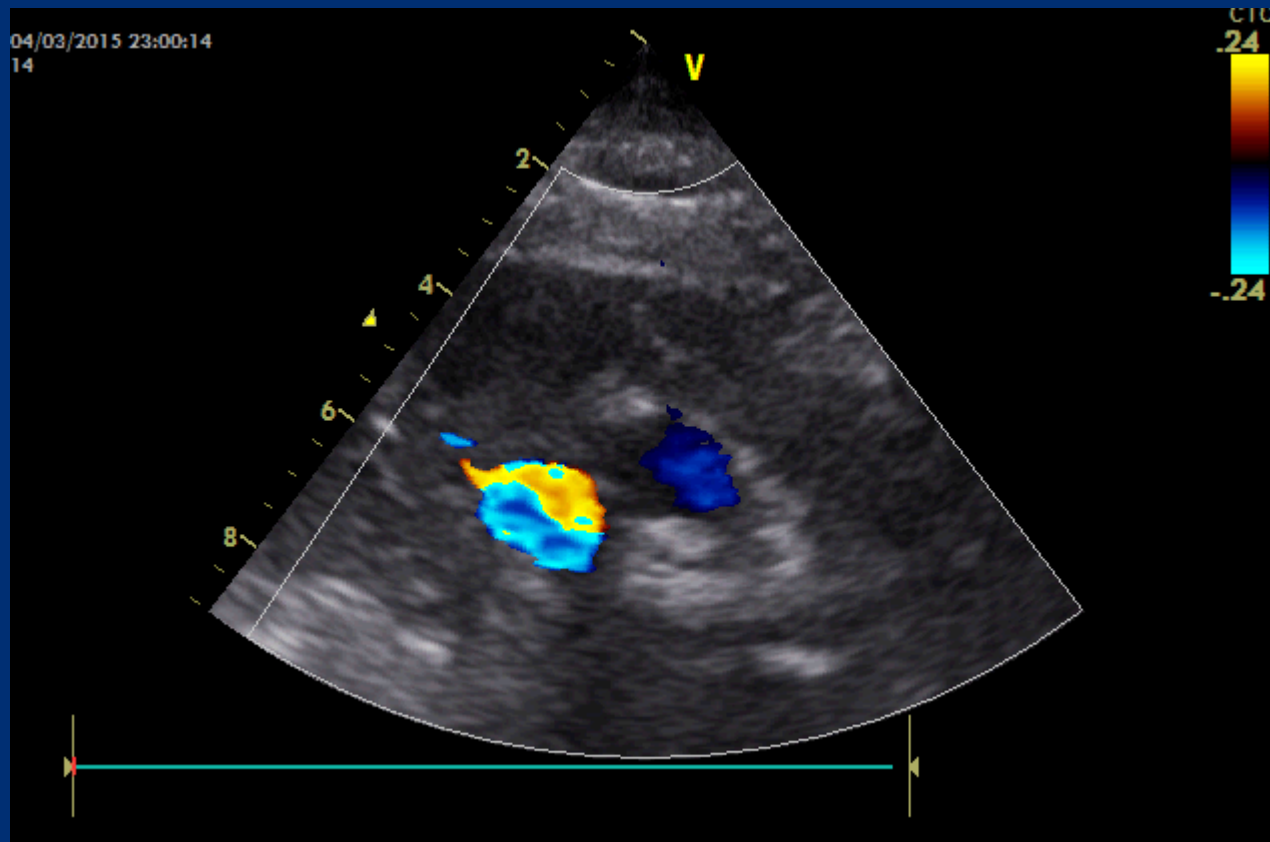
## Ma in Utic..... alle ore 2 del mattino

- Donna di anni 85 con stenosi aortica severa sintomatica trattata con TAVI ( Lotus )
  - Cleareance della creatinina di 30 ml/min
  - Hb 9 gr/dl (ingresso 10gr/dl) diuresi conservata
  - PA 110/80mmHg Saturazione 98% in O<sub>2</sub> Fc 72bpm in RS
- 
- Accusa dolori addominali diffusi

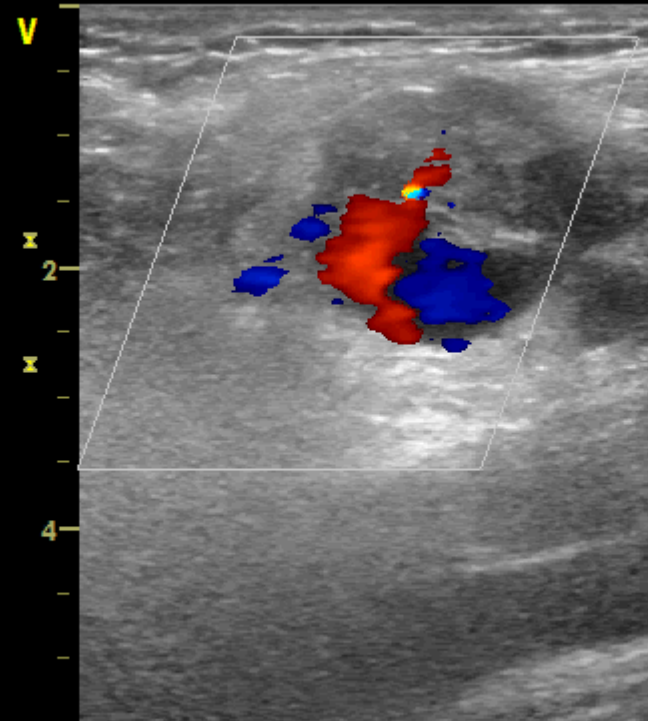
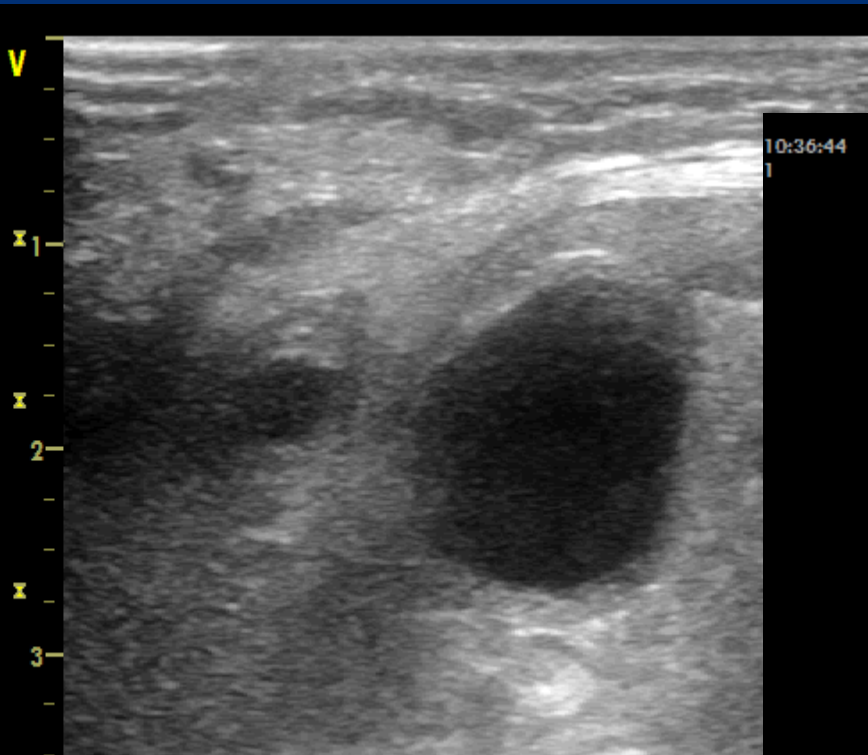




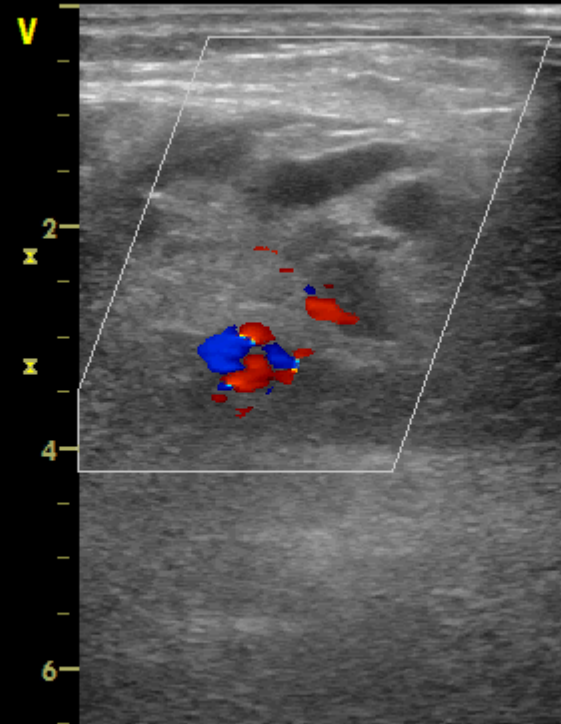
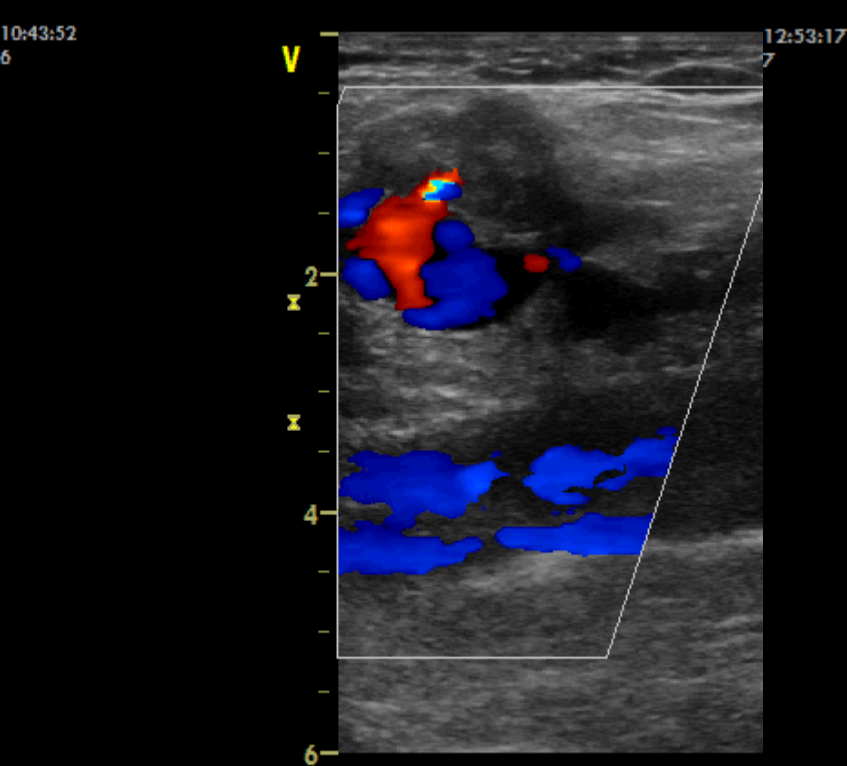
# Asse trasverso per le a.renali



Capita sempre a me alle 3 del mattino... pz sudato PA  
100/80 mmHg dolore inguine destro HB 8.5gr/dl



Non segni di compressione vasale decido per una compressione ( la sua Hb era quella dell'ingresso i suoi valori pressori secondari ai nitrati ev)



# FAV

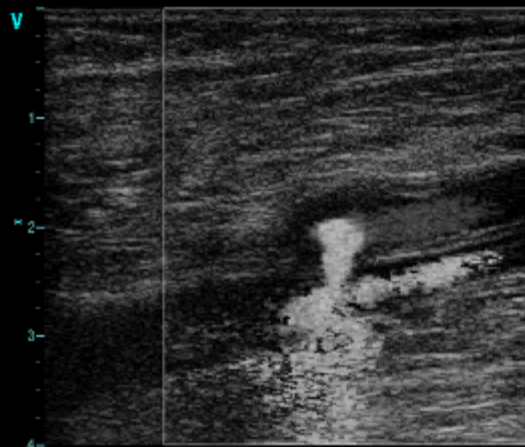
di vaia, cosimo  
08/10/1953

GE Vingmed Ultrasound 9L  
15/01/15 11:05:15 USR LEA

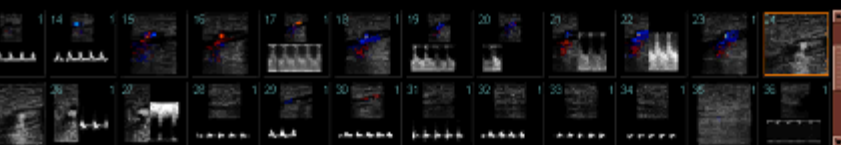
MI 1.2  
TI 0.1

13/04/15 17:41:54

15/01/2015 11:05:15  
località: 0.9 %

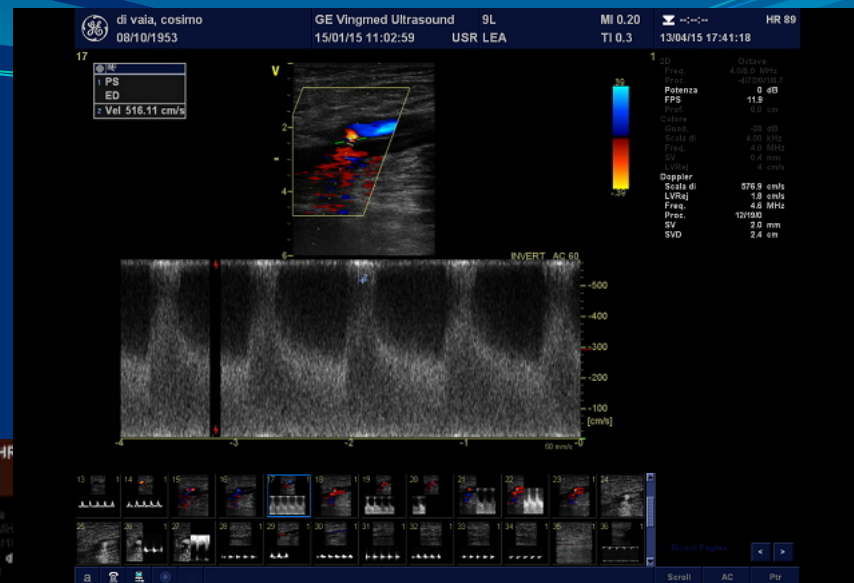


2D  
Freq. 4.080 MHz  
Prof. 107.0 mm  
Potenza 0 dB  
FPS 35.0  
Prof. 4.0 cm  
Color  
Gain -12 dB  
Scala di 4.00 MHz  
Freq. 4.0 MHz  
SV 0.4 mm  
LVIRaj 6 cm/s  
Doppler  
Scala di cm/s  
Scala di cm/s  
LVIRaj cm/s  
Freq. MHz  
Prof. 17 mm  
SV mm  
SVD cm



Rivedi Pagina

Velocità Ptr



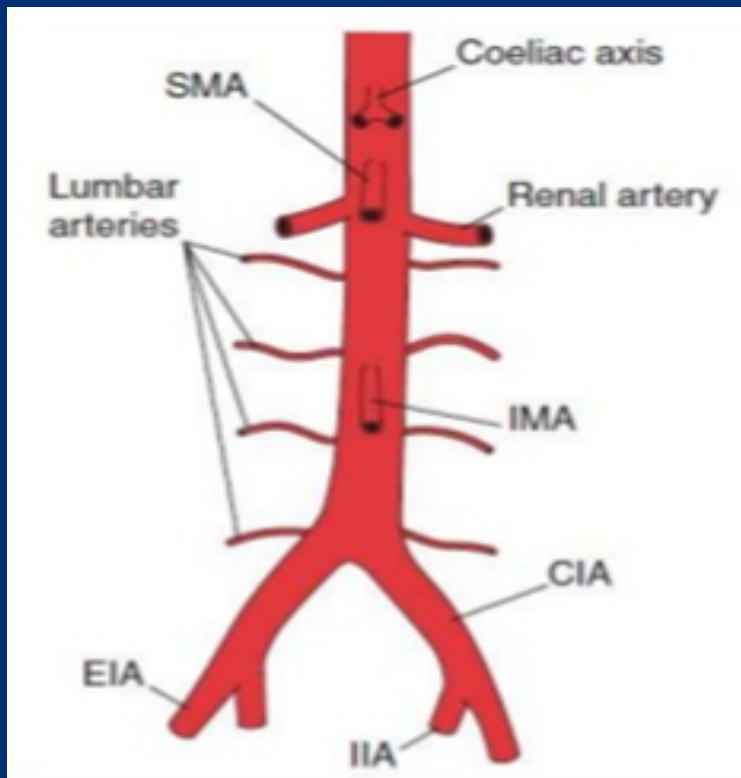
... e ora dove metto la sonda



# Color doppler arterioso arti inferiori

- Anatomia
- Color doppler normale
- Criteri di valutazione
- Cause delle malattie arteriose

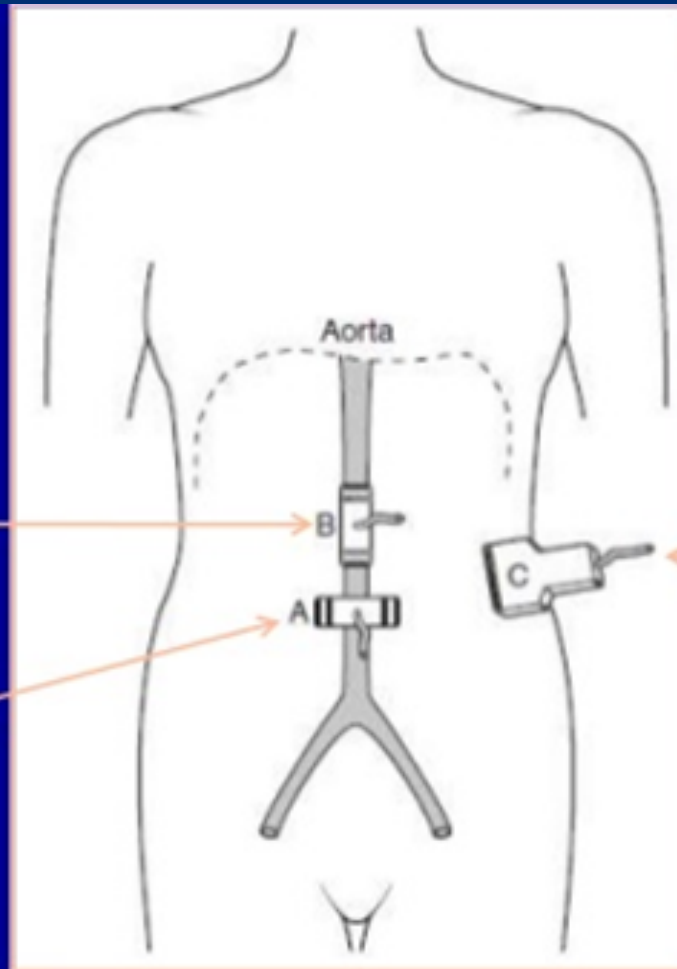
# Anatomia dell'asse aorto-iliaco



Origina a sinistra della linea mediana  
a differenza della cava inferiore

Dà origine ai vasi viscerali e alle arterie  
lombari e freniche

# Trasduttore e scansione per l'asse aorto-iliaco



Sagittal or  
longitudinal

Transverse

Frequenze 3-6 MHz

Volume campione di  
2mm

Filtro 50-100 Hz

Coronal

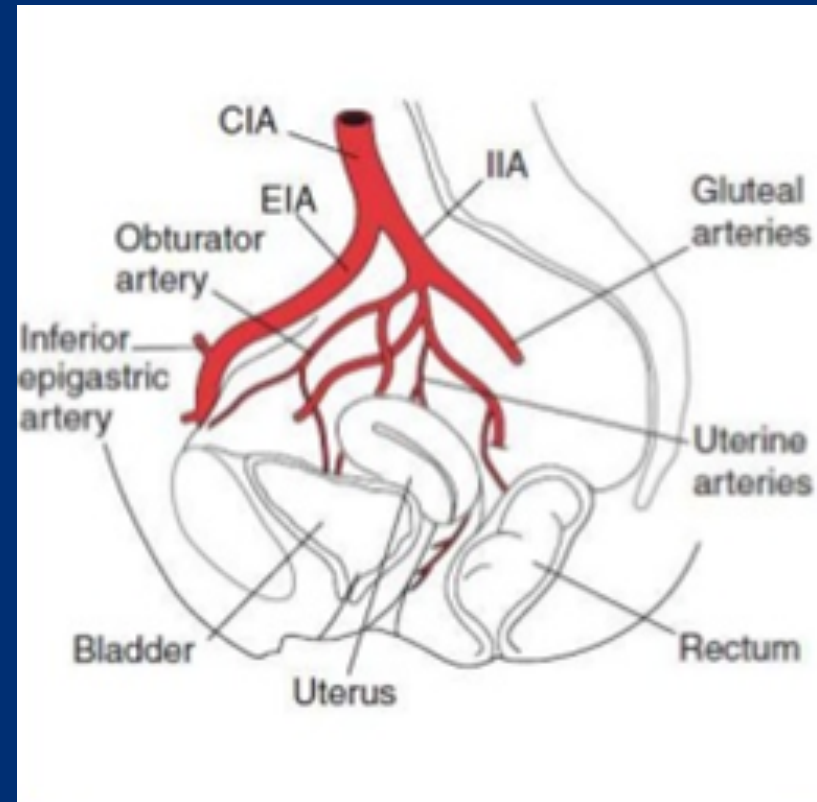
Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.

Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

# Anatomia della arteria iliaca

L'arteria iliaca comune lunga 4-5 cm si estende da L4 all'articolazione sacroiliaca dove si divide in interna ed esterna è accompagnata dalla vena

L'arteria iliaca esterna prosegue sino al legamento inguinale dove ha origine l'arteria femorale comune dà origine all'arteria epigastrica inferiore che discende nella pelvi

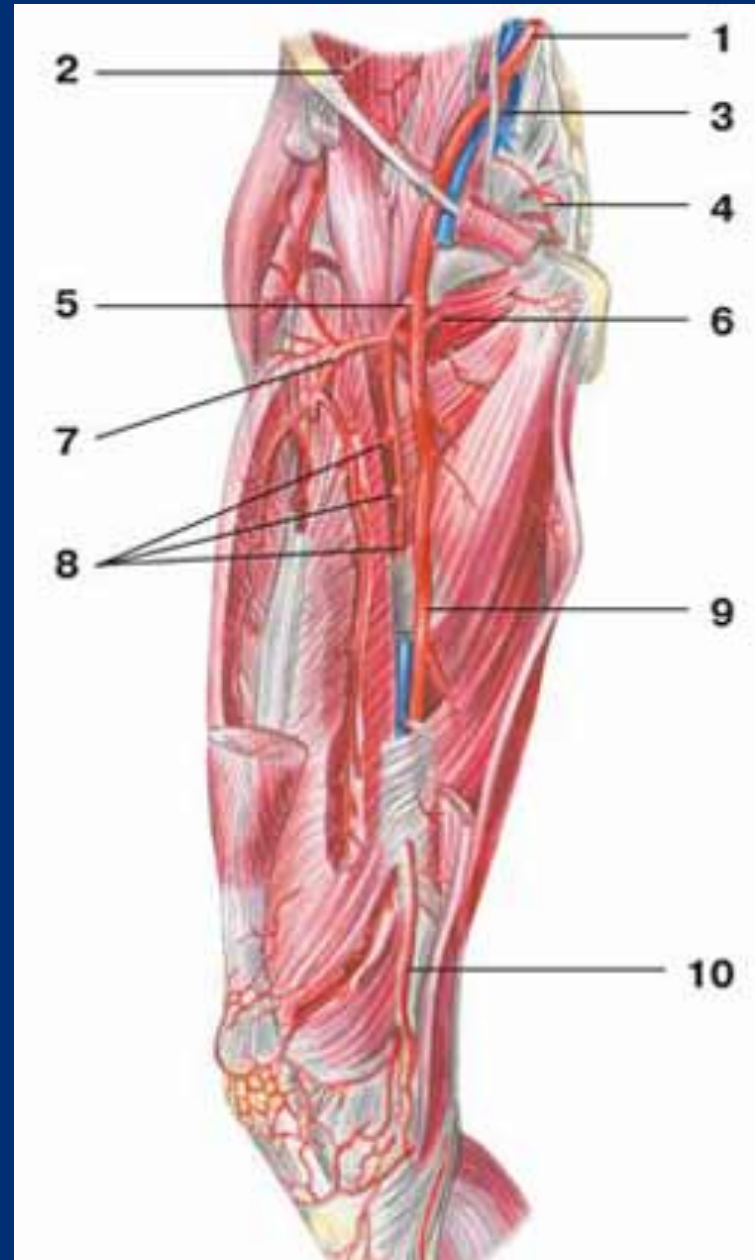


# L'arteria femorale

L'arteria femorale comune si dirige superficialmente all'inguine per dividersi in superficiale e profonda (4-6 cm) Accompagnata da nervo e vena Ricordare NAVE !!!!!

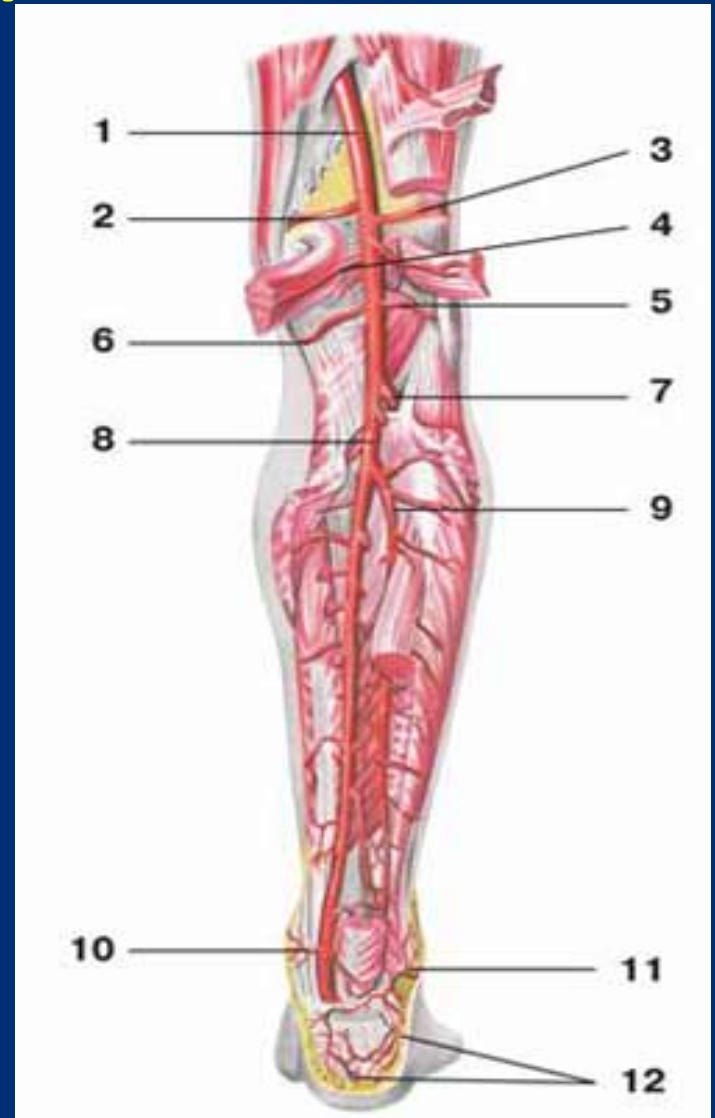
L'arteria superficiale decorre medialmente nella coscia sino all'iato degli adduttori per continuare nella poplitea

L'arteria femorale profonda decorre dietro il tronco della femorale sino a raggiungere la superficie mediale del femore dà origine a una rete di anastomosi con la poplitea e la superficiale



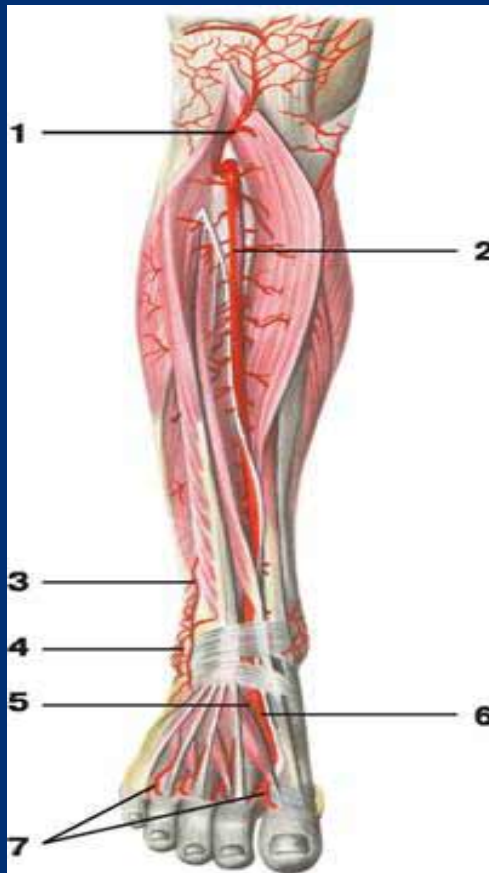
# L'arteria poplitea

Origina al di sotto del canale degli adduttori passando verticalmente la fossa poplitea dividendosi nella tibiale anteriore e tronco tibio-peroniero è accompagnata dalla vena e dal nervo

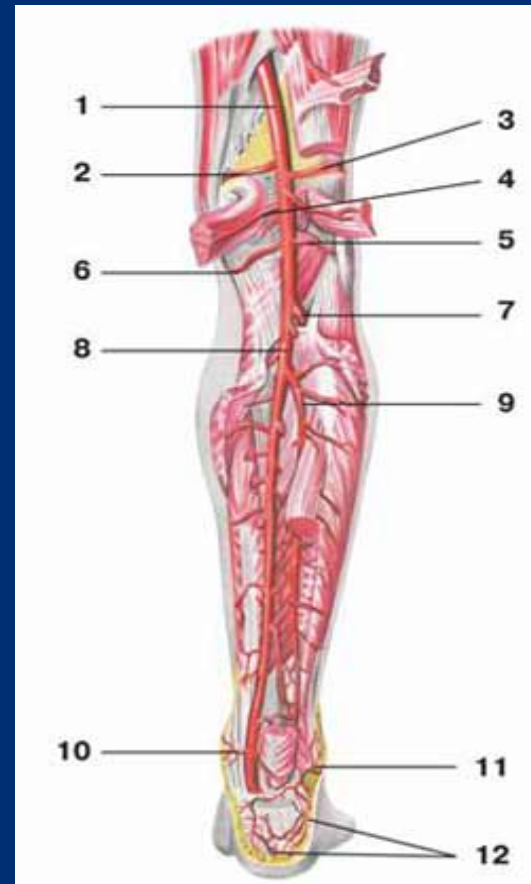


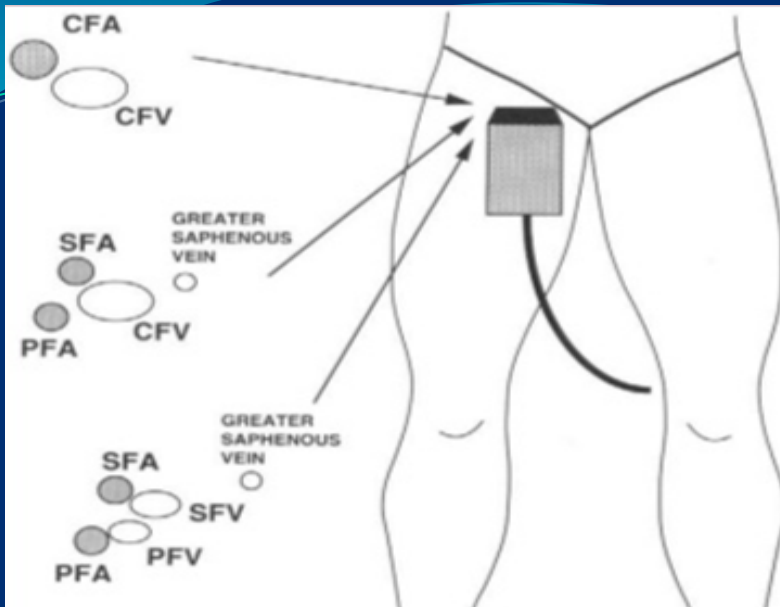
# Arterie di gamba

**Arteria tibiale anteriore**



**Arteria tibiale posteriore**



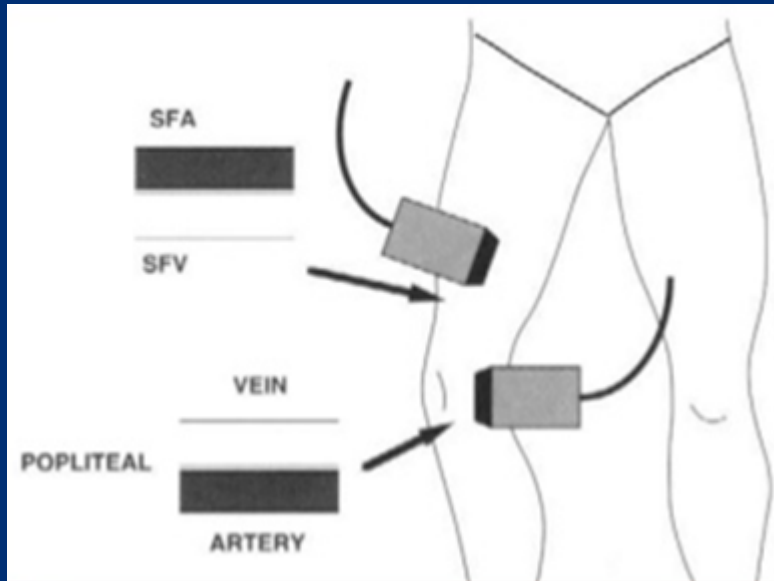


Sonda lineare 5-10 Mhz

Per il campionamento  
doppler 4-7 MHz

Volume campione 2 mm

Filtro 50-100 Hz

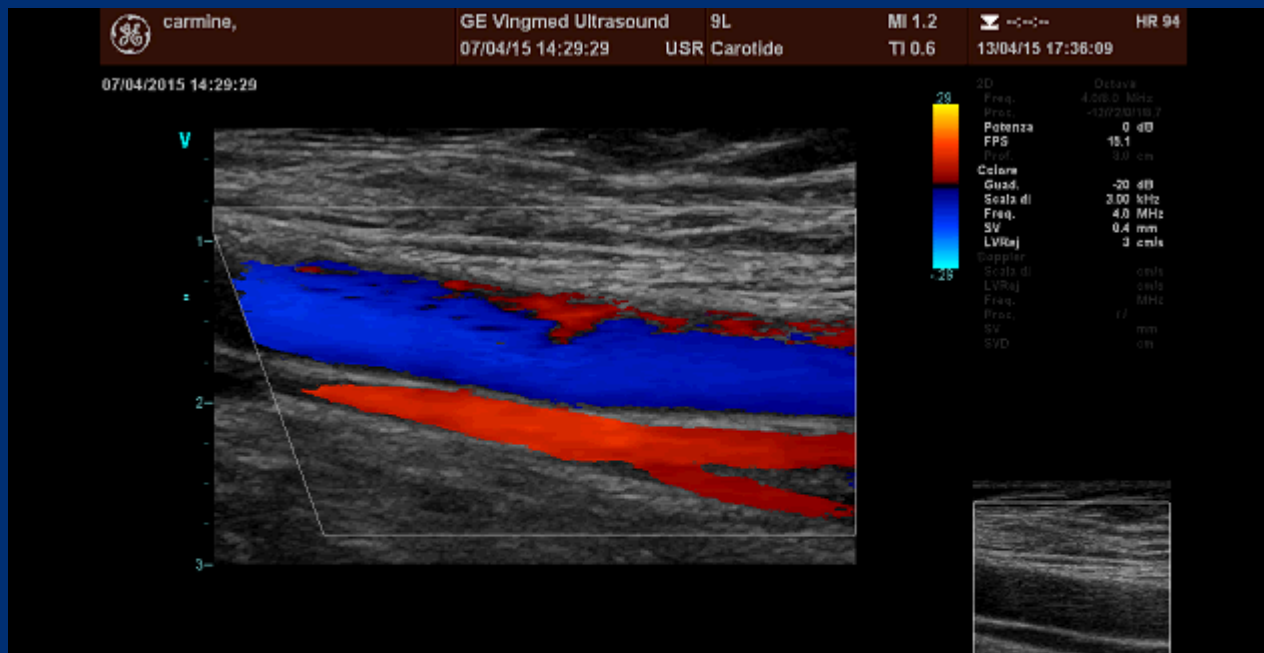
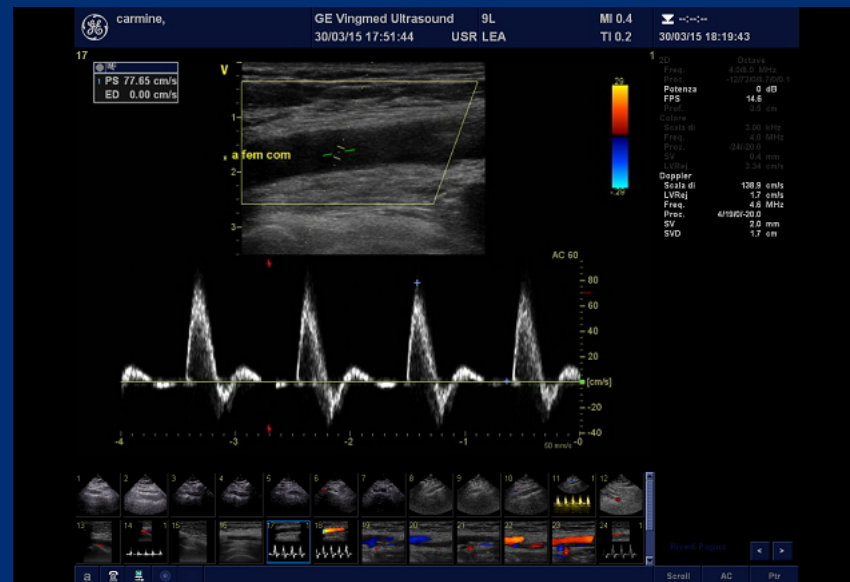
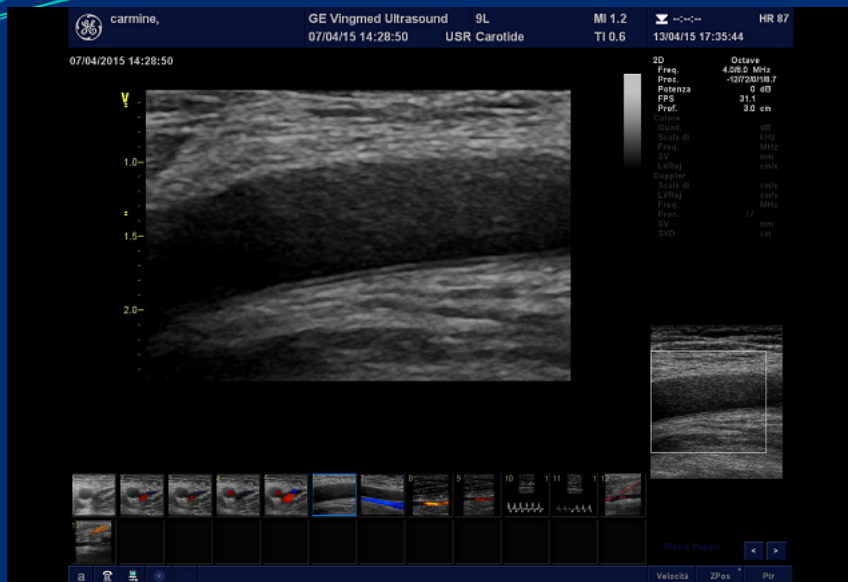


# Normali diametri delle arterie degli arti inferiori

|                              |            |
|------------------------------|------------|
| • Sub-diaphragmatic aorta    | 21 – 24 mm |
| • Infra-diaphragmatic aorta  | 17 – 20 mm |
| • Common iliac artery        | 10 – 12 mm |
| • External iliac artery      | 8 – 10 mm  |
| • Common femoral artery      | 7 – 9 mm   |
| • Superficial femoral artery | 6 – 8 mm   |
| • Popliteal artery           | 4 – 6 mm   |

# Color doppler arterioso arti inferiori

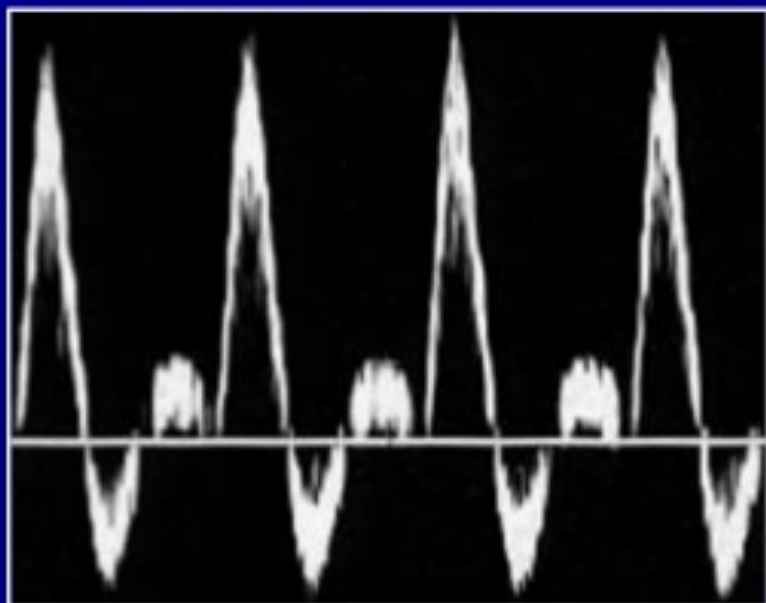
- Anatomia
- Valutazione b mode e doppler (Pw e colore )
- Criteri di valutazione nel normale e patologico
- Cause delle malattie arteriose





# Normal triphasic waveform of peripheral arteries

## Arterial high resistance flow



Narrow frequency band

Steep systolic increase

Quick drop

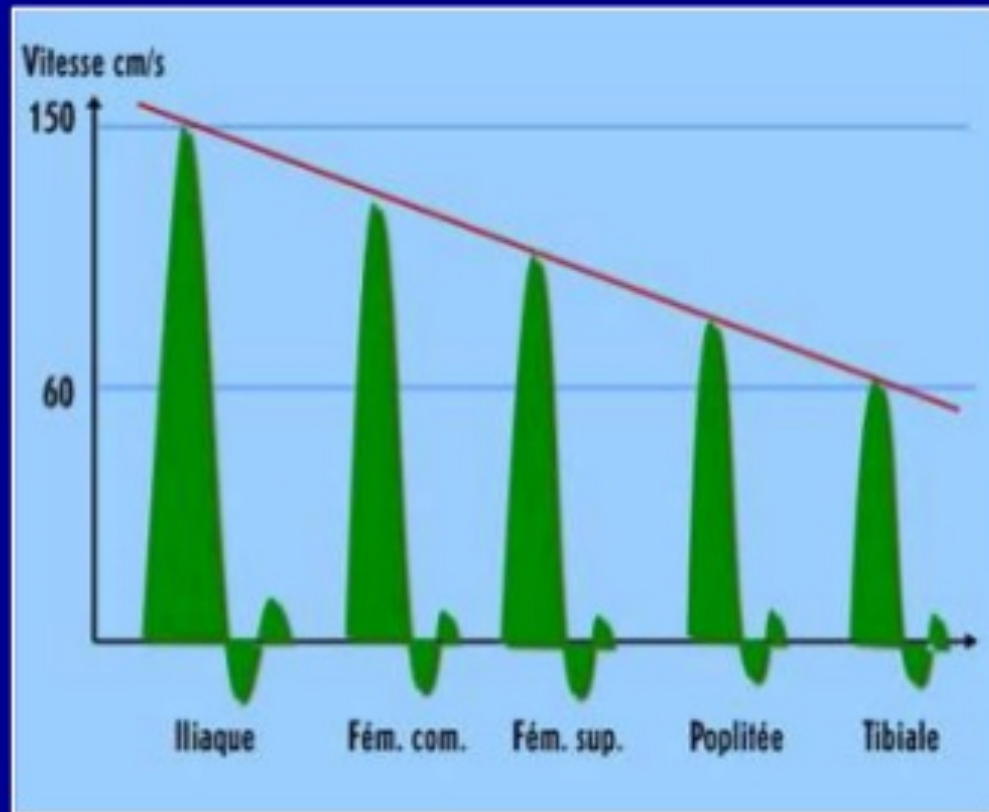
Early diastolic reverse flow  
( $\frac{1}{5}$  of systolic flow amplitude)

Late diastolic short forward flow

ABPI: Ankle Brachial Pressure Index

Stiegler H & Brandl R. Ultraschall in Med 2009 ; 30 : 334 – 363.

# Normal PSV of lower limb arteries



# Pulsatility index

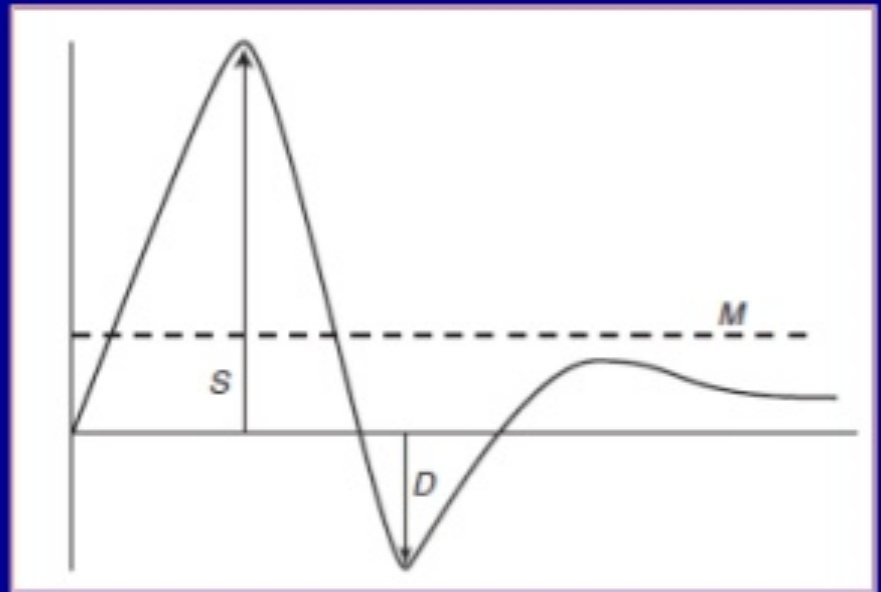
Most commonly used of all indices

**S: Systolic**

**D: Minimum diastolic**

**M: Mean**

**PI:  $S - D / M$**



Normal PI: 4 – 13 (average 6.7)

Depending on location of peripheral arteries

# Factors influencing pulsed Doppler waveform

## Complicate evaluation

- |                                         |                               |
|-----------------------------------------|-------------------------------|
| • <b>Cardiac pump function</b>          | Cardiac insufficiency         |
| • <b>Aortic valve function</b>          | Aortic stenosis/insufficiency |
| • <b>Course of vessel</b>               | Tortuosity                    |
| • <b>Vessel branching</b>               |                               |
| • <b>Peripheral vascular resistance</b> | Peripheral inflammation       |
|                                         | Polyneuropathy                |
|                                         | Warm or cold extremity        |
|                                         | Vaso-spastic disorders        |

## Arterial monophasic flow

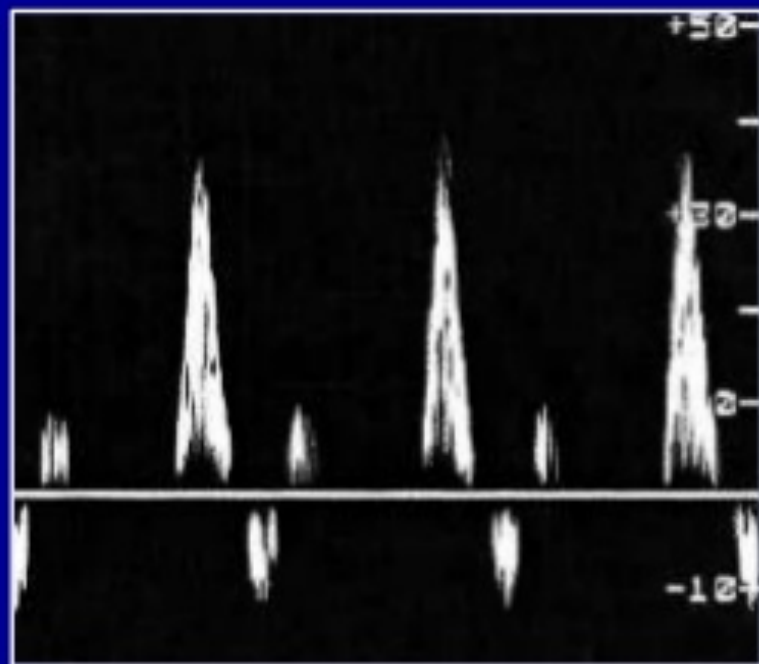
- **Hyperemic** (normal PSV & normal RT\*)  
Exercise  
Fever  
Downstream infection  
Temporary arterial occlusion by blood pressure cuff
- **Tardus-Parvus waveform** (low PSV & longer RT)  
Distal to severe stenosis or occlusion

\* Rise time: Time between beginning of systole & peak systole

# Hyperemic monophasic flow

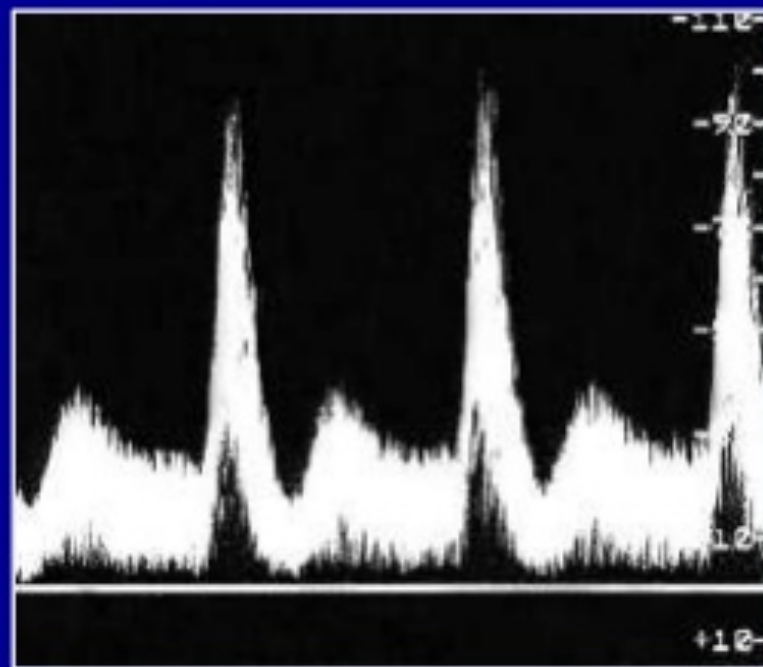
## Following exercise

Normal DPA at rest



Normal triphasic waveform

Following exercise



Monophasic hyperemic flow

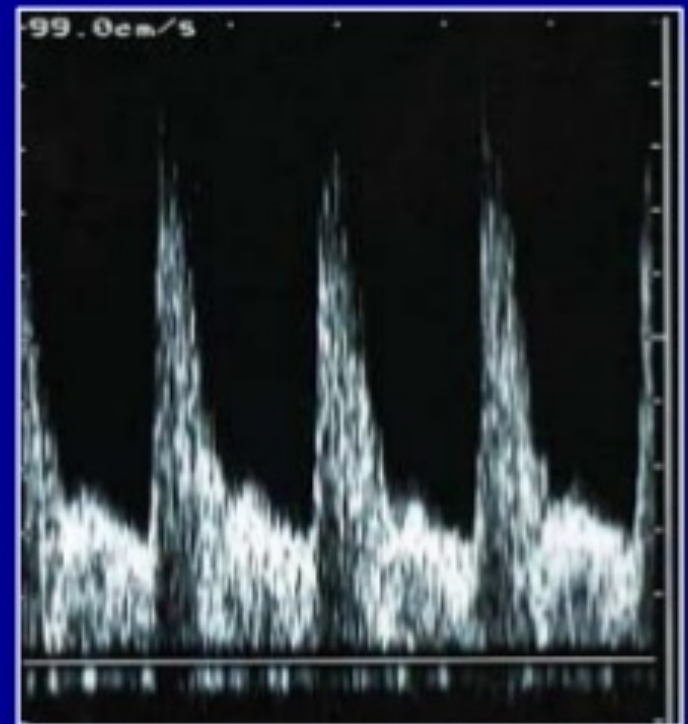
# Hyperemic flow

## Phlegmon of foot

**Monophasic waveform**

**Normal PSV**

**Normal rise time**



# Color doppler arterioso arti inferiori

- Anatomia
- Color doppler normale
- Criteri di valutazione
- Cause delle malattie arteriose

# Classificazione Fontaine & Leriche

| Stage | Complains                       |
|-------|---------------------------------|
| I     | Asymptomatic                    |
| II a  | Mild claudication               |
| II b  | Moderate to severe claudication |
| III   | Ishemic rest pain               |
| IV    | Ulcer or gangrene               |

# Ankle Brachial Pressure Index (ABPI)

Continuous wave Doppler (takes 10 - 15 min)

❶ Dorsalis  
pedis artery



❷ Posterior  
tibial artery

❸ Peroneal artery

Highest ankle pressure / highest brachial pressure

Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.  
Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

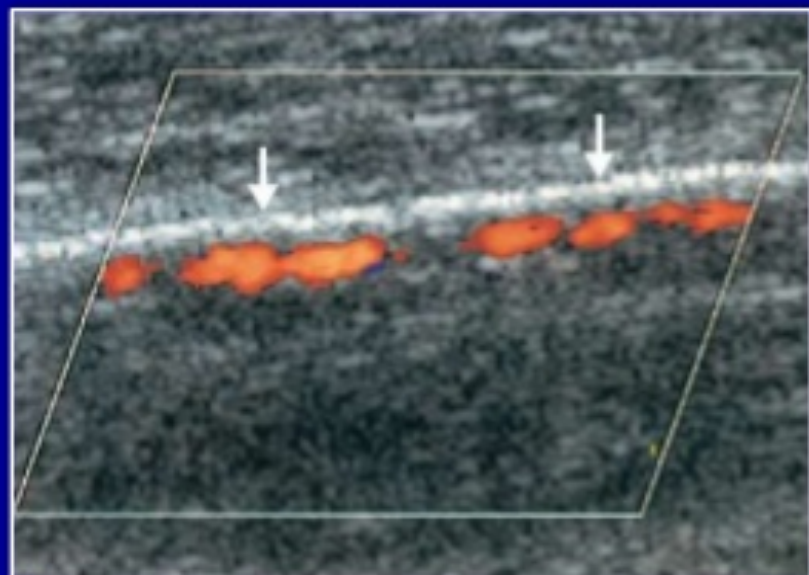
## Grading arterial disease using ABPI

| ABPI       | Comment                                            |
|------------|----------------------------------------------------|
| > 1.3      | Falsely high value (suspicion of medial sclerosis) |
| 0.9 – 1.3  | Normal finding                                     |
| 0.75 – 0.9 | Mild PAD                                           |
| 0.4 – 0.75 | Moderate PAD                                       |
| < 0.4      | Severe PAD                                         |

**ABPI: Ankle Brachial Pressure Index**

Stiegler H & Brandl R. Ultraschall in Med 2009 ; 30 : 334 – 363.

# ABPI in diabetics



**Ankle pressure**      **280 mmHg**

**Brachial pressure**   **120 mmHg**

**ABPI**                      **2.3**

Calcification of vessel walls

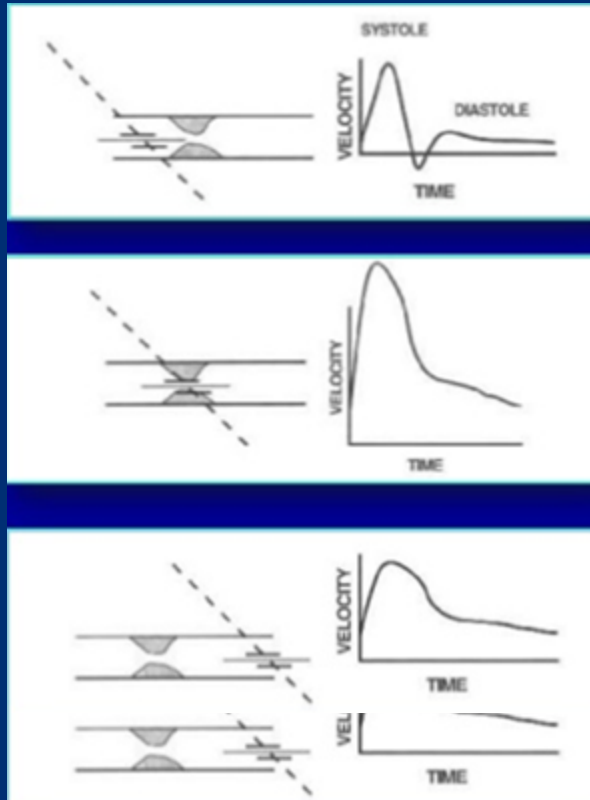
Beaded appearance of color flow

Falsely elevated recordings in diabetic patients

Calcified & rigid arterial walls

# Segni diretti e indiretti di stenosi

Angolo di  
correzione !!!



**Proximal to stenosis**

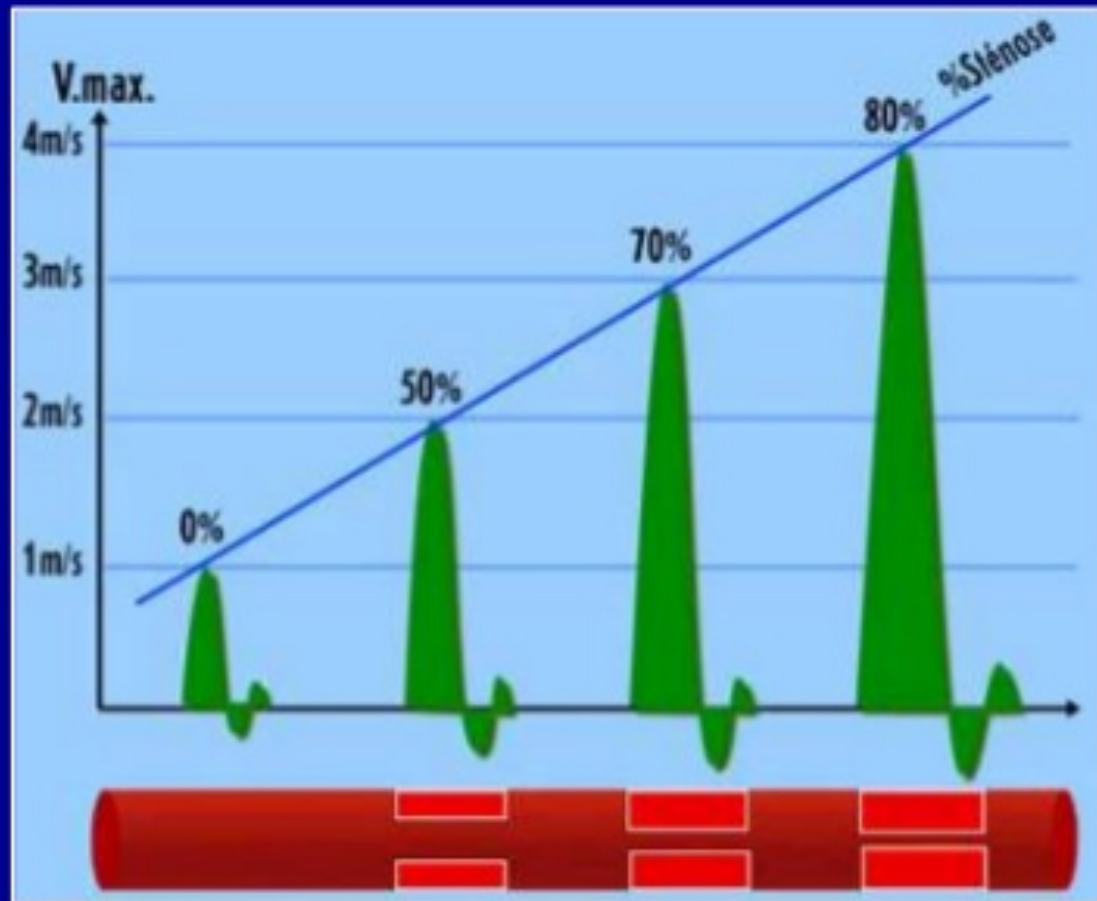
**At site of stenosis**

**Distal to stenosis**

**DISTAL TO STENOSIS**

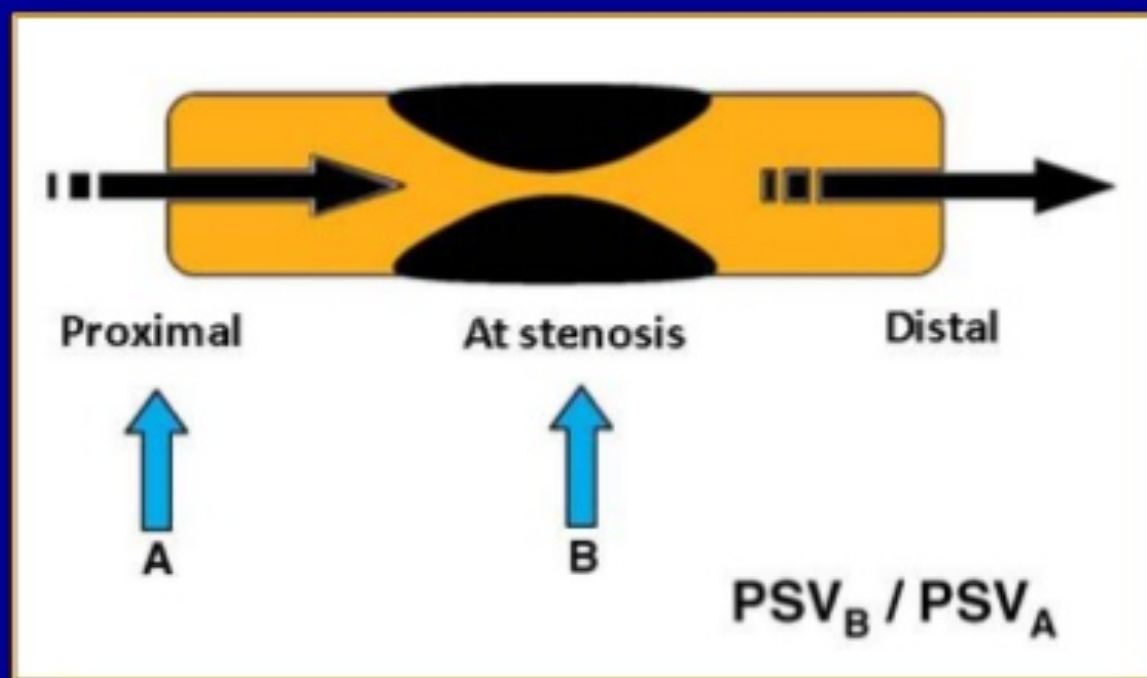
# Grading of lower limb artery stenosis

## PSV at site of stenosis



# Grading of lower limb artery stenosis

## PSV ratio

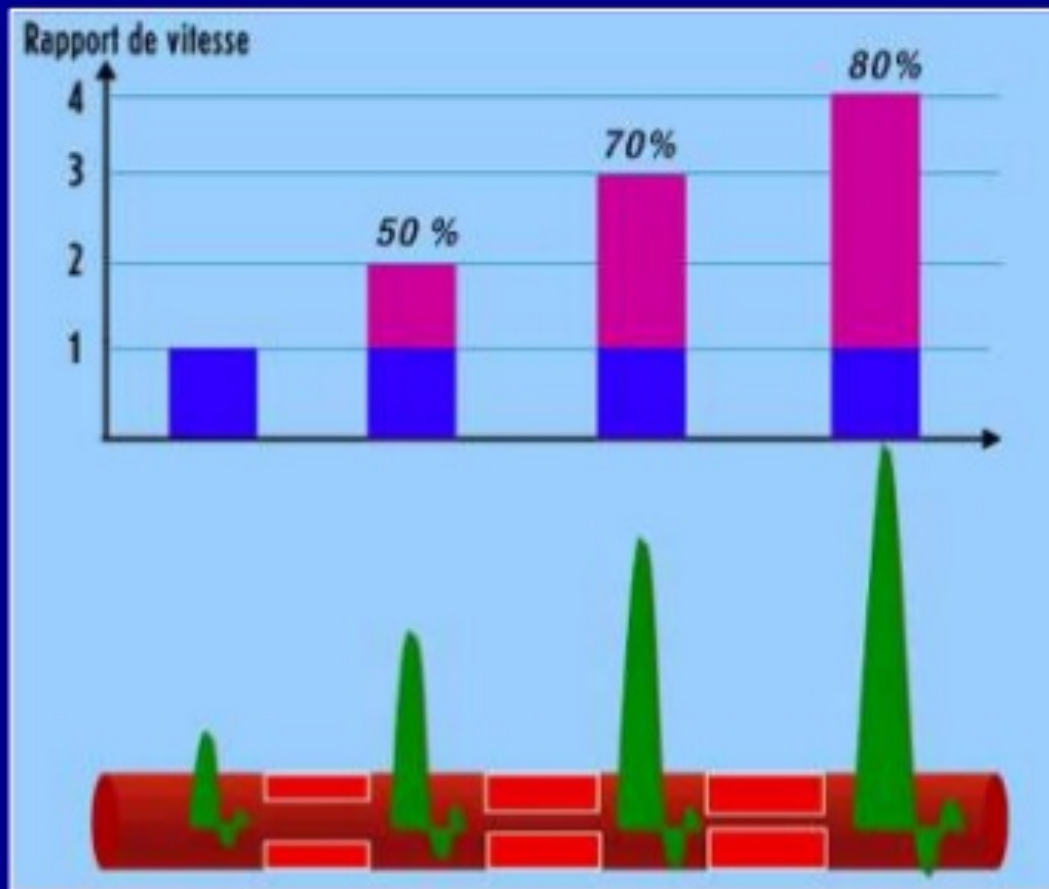


Proximal: 2 cm proximal to stenosis

At stenosis : Same Doppler angle if possible

# Grading of lower limb artery stenosis

## PSV ratio



## Grading of arterial stenosis

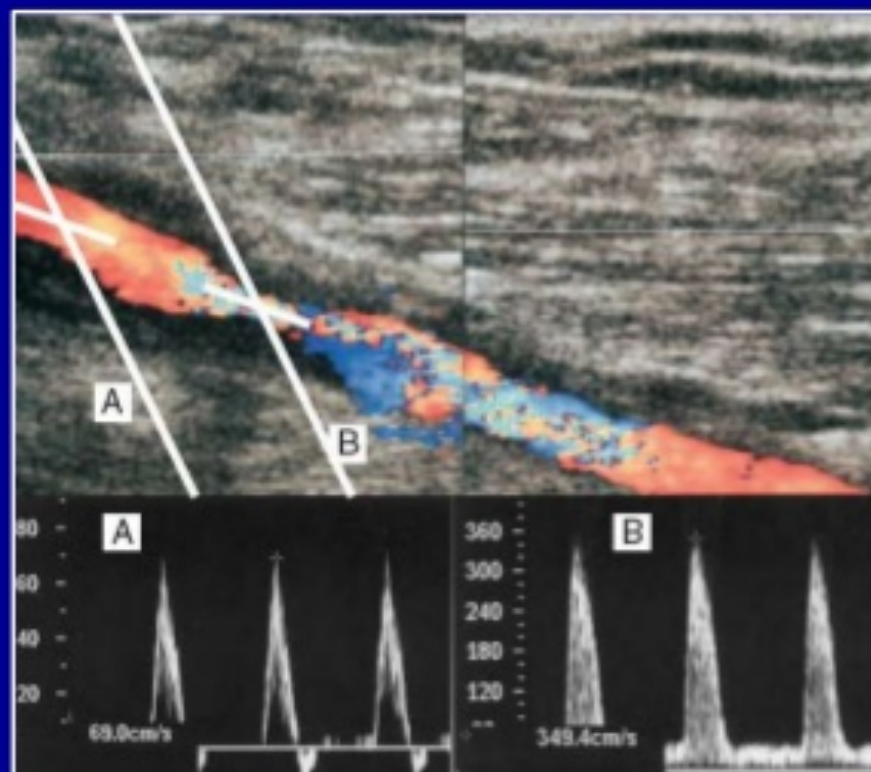
### SFA:

PSV of A 69 cm/sec

PSV of B 349 cm/sec

$B / A = 349 / 69 = 5$

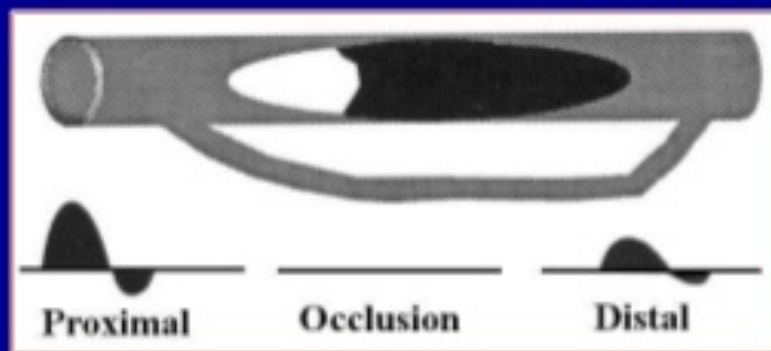
**> 80% diameter stenosis**



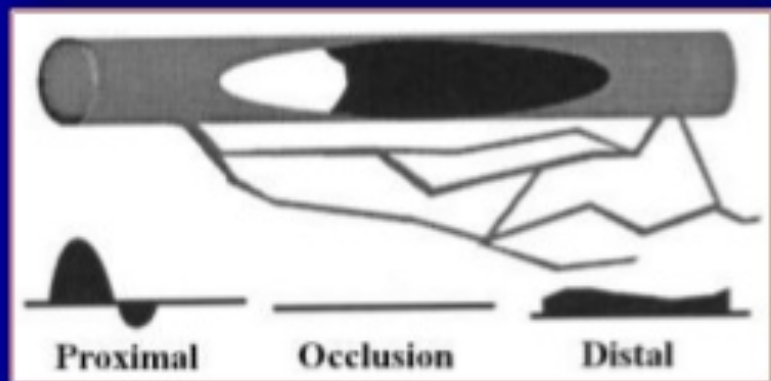
Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.  
Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

# Grading of lower limb artery stenosis

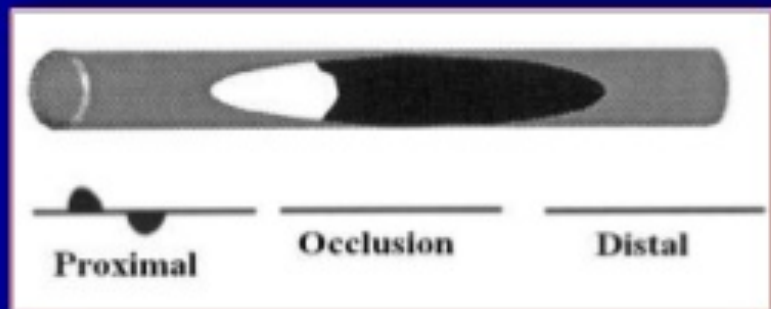
## Effect of collaterals



**Excellent collaterals**



**Poor collaterals**

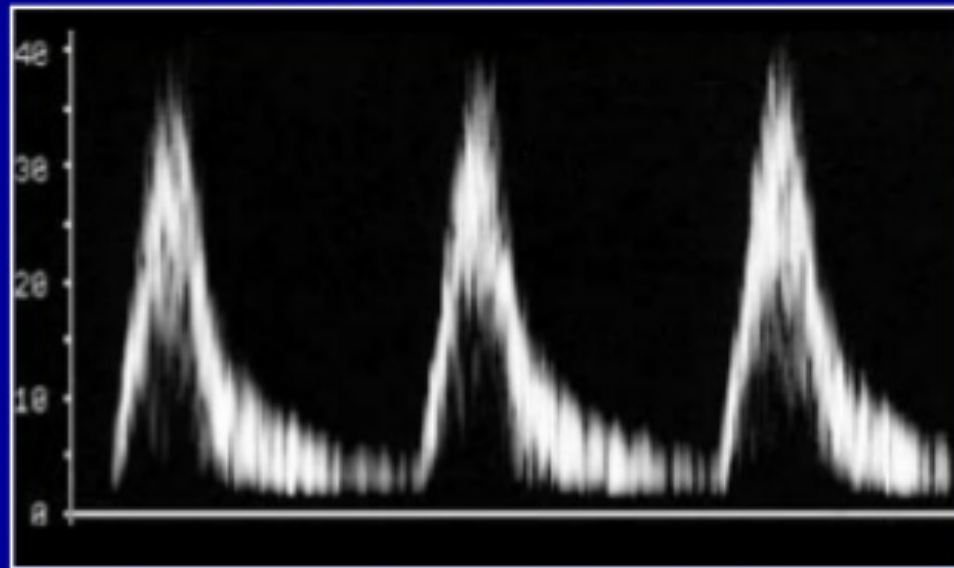


**Absence of collaterals**

# Grading of lower limb artery stenosis

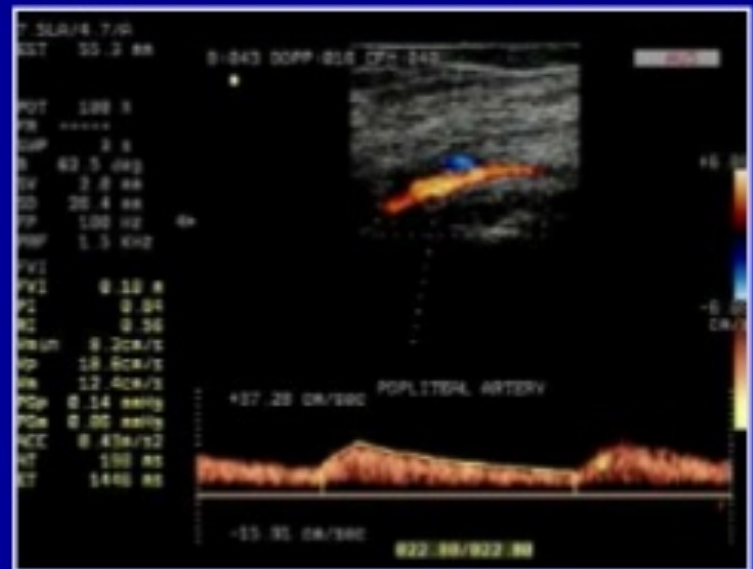
## Flow pattern distal to lesion

### Damping waveform



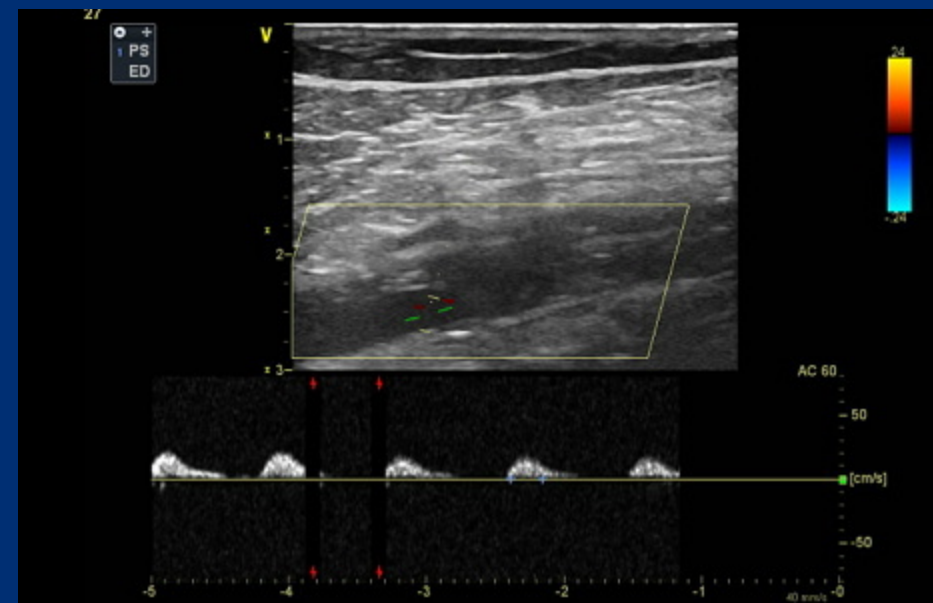
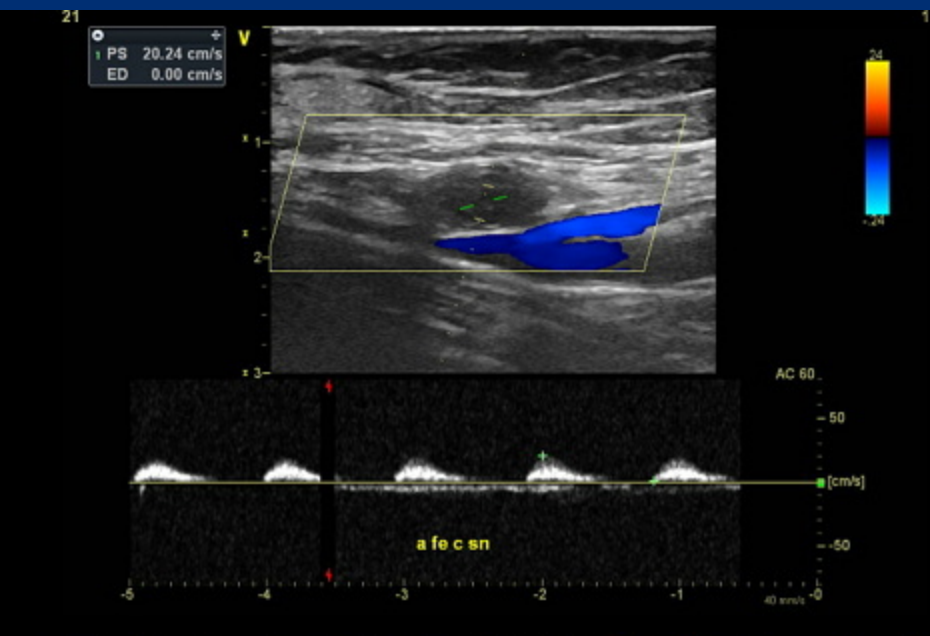
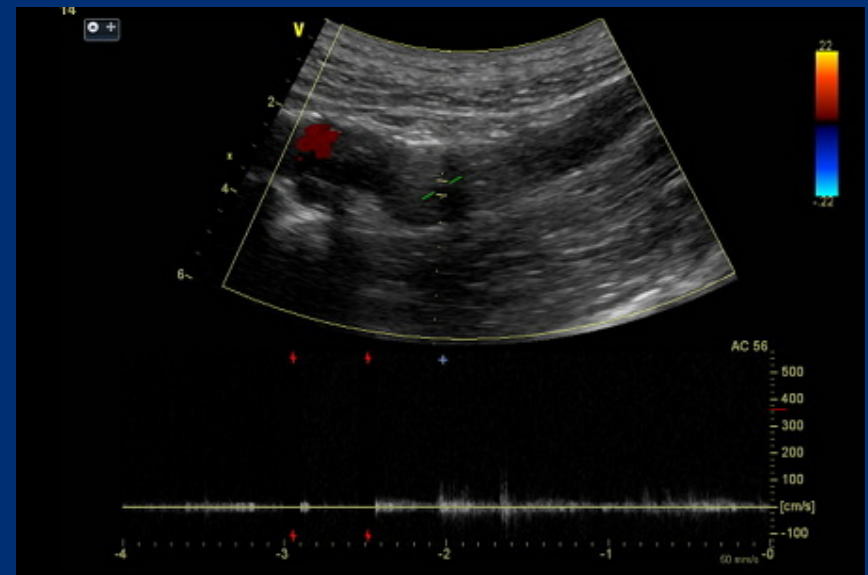
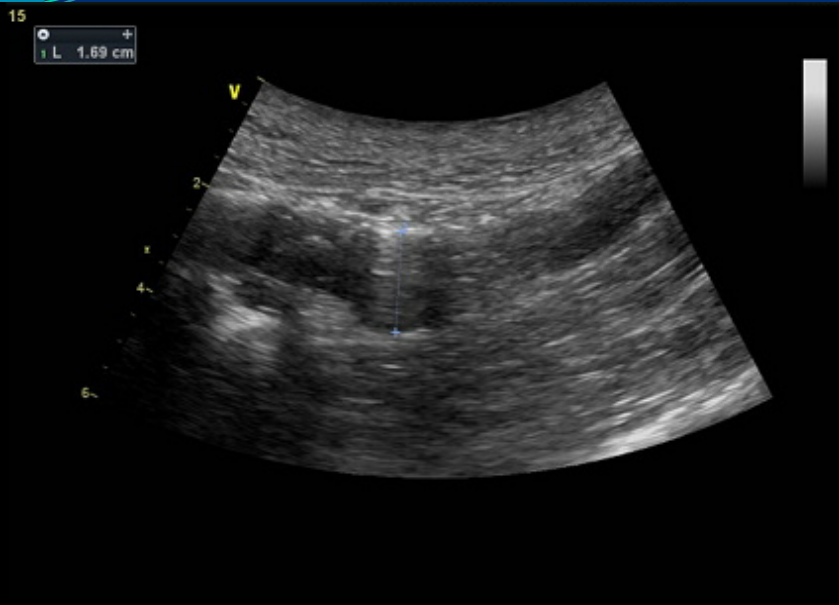
Increased systolic rise time  
Loss of pulsatility

### Tardus-Parvus waveform

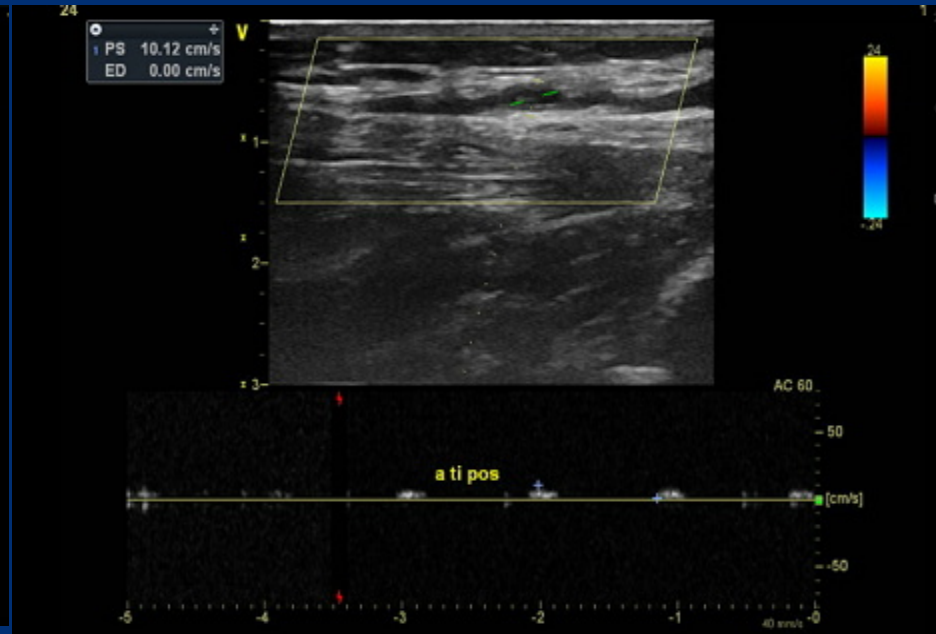
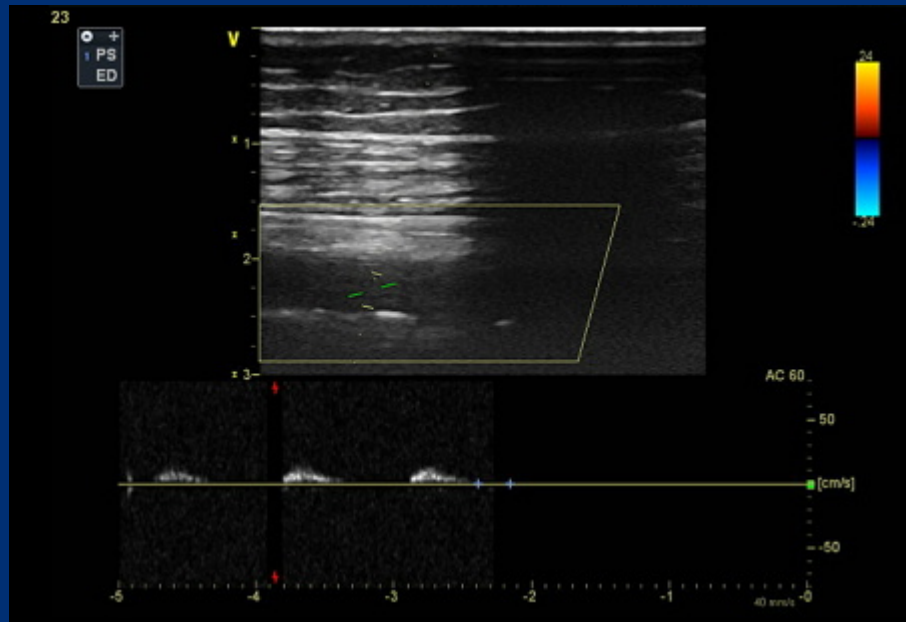


**Tardus:** Longer rise time  
**Parvus:** Low PSV  
Severe stenosis or occlusion

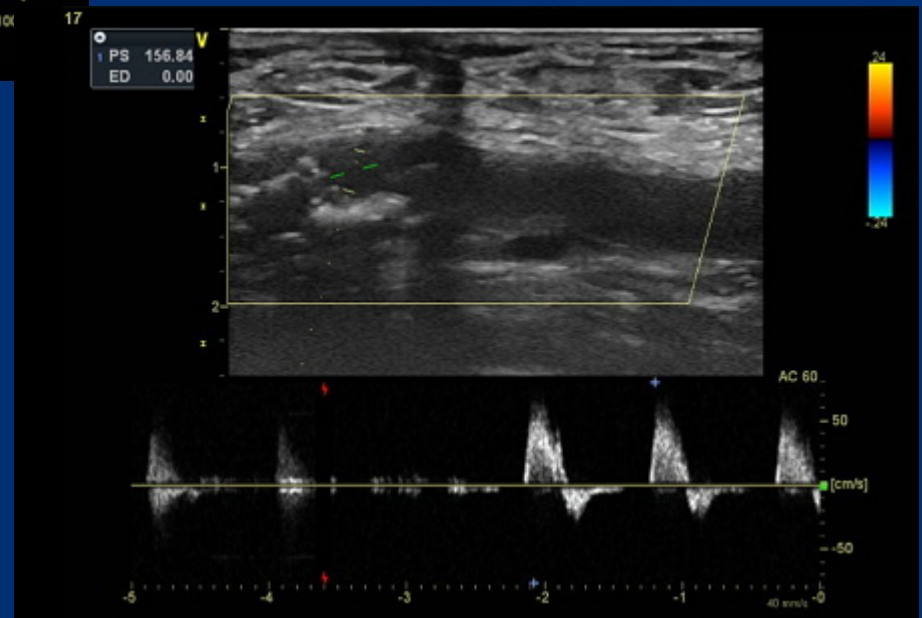
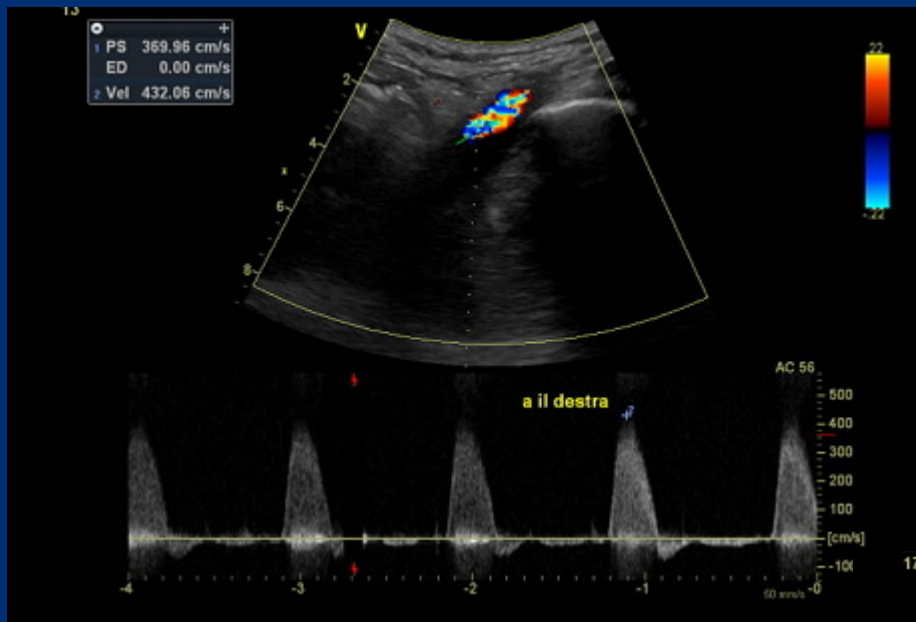
## A. Iliaca comune sinistra



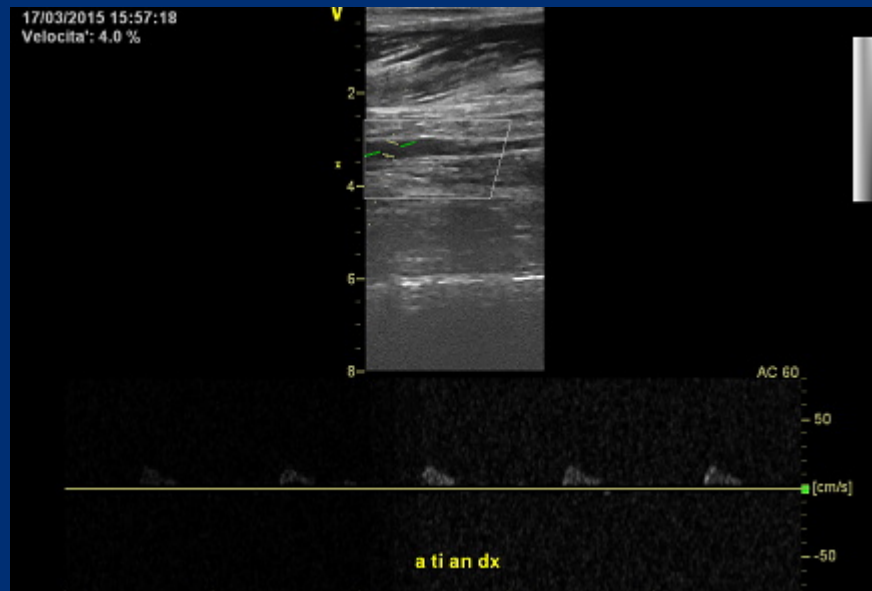
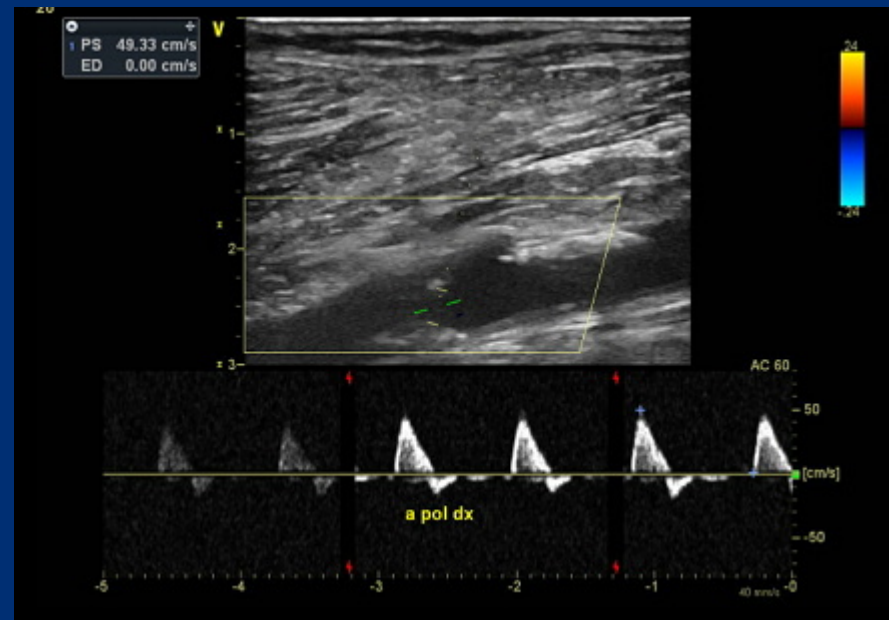
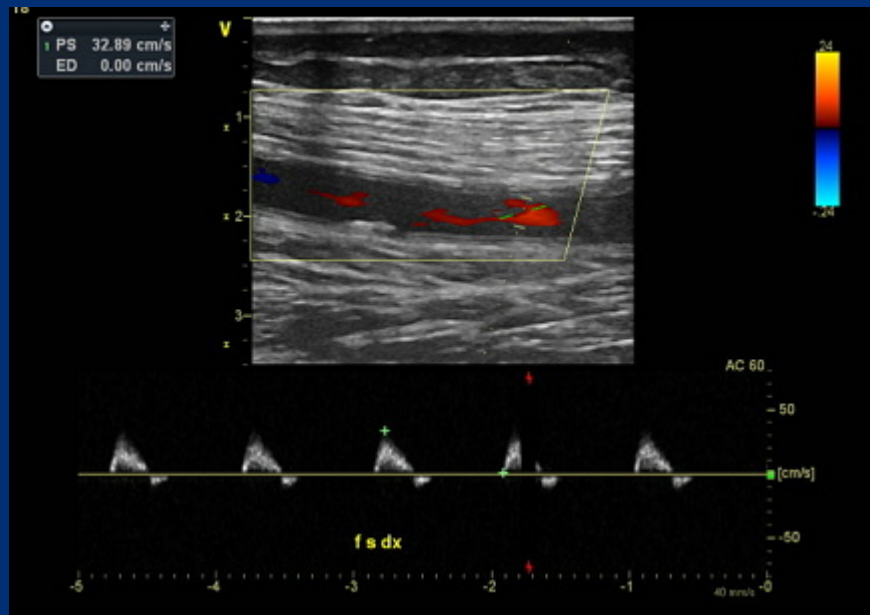
# Tardus-Parvus



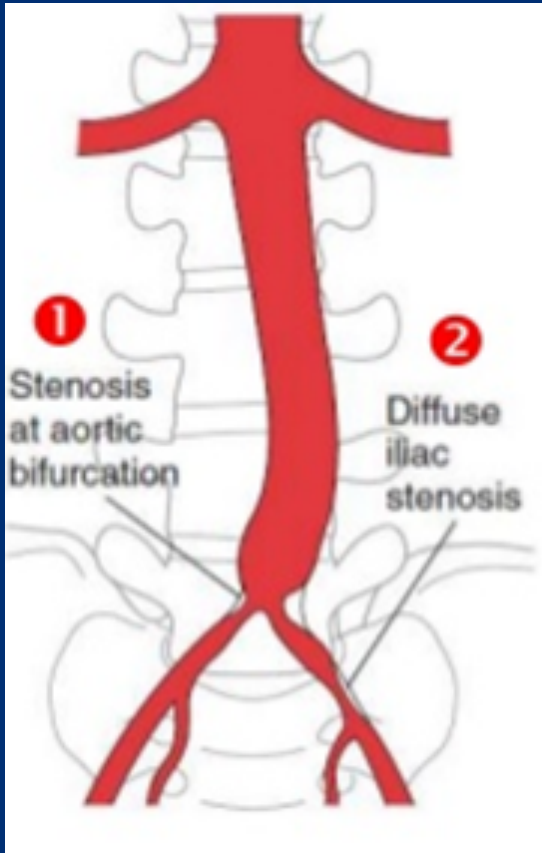
# Psv al tratto stenotico



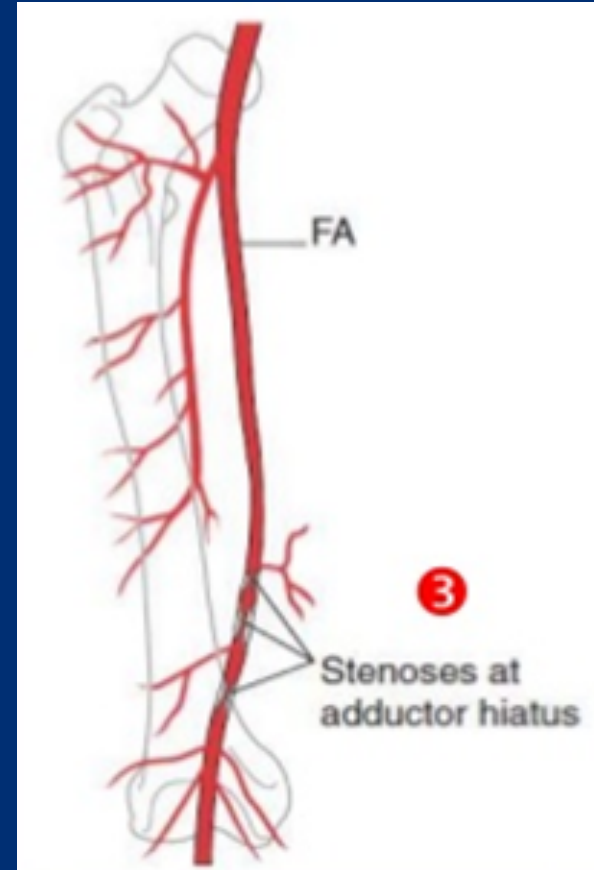
# Velocità a valle di stenosi



# Siti di stenosi più frequenti



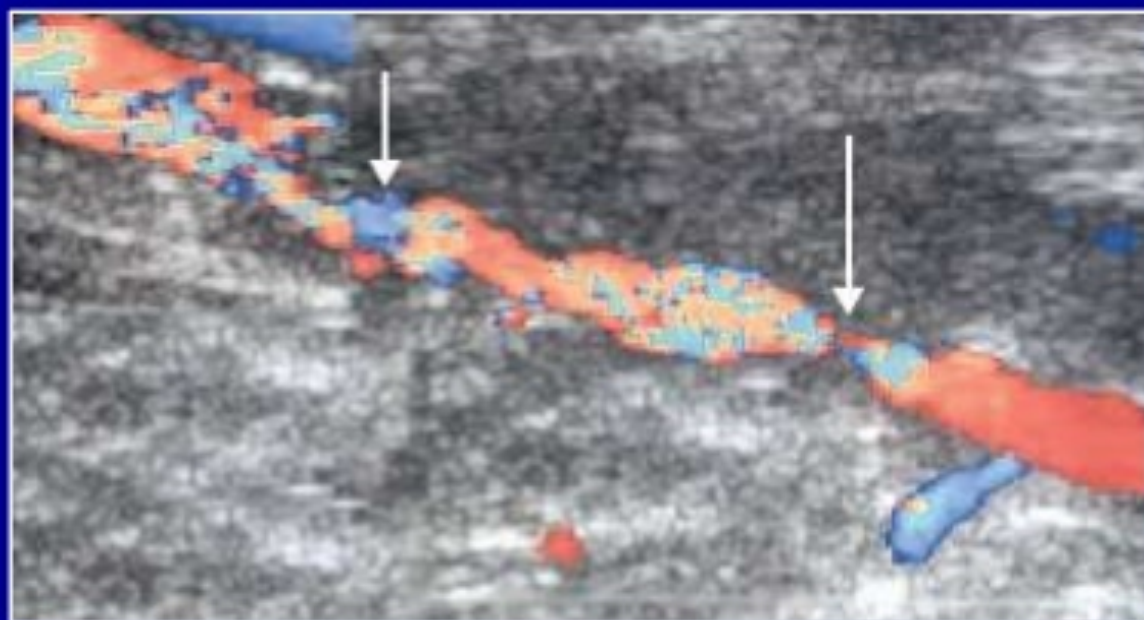
Aorto-iliaco 25%



Femoro-popliteo 65%  
Infra-popliteo 10%

Myers KA & Clough A: Making sense of vascular ultrasound. Arnold, London, 2004.

## Two severe stenosis of SFA

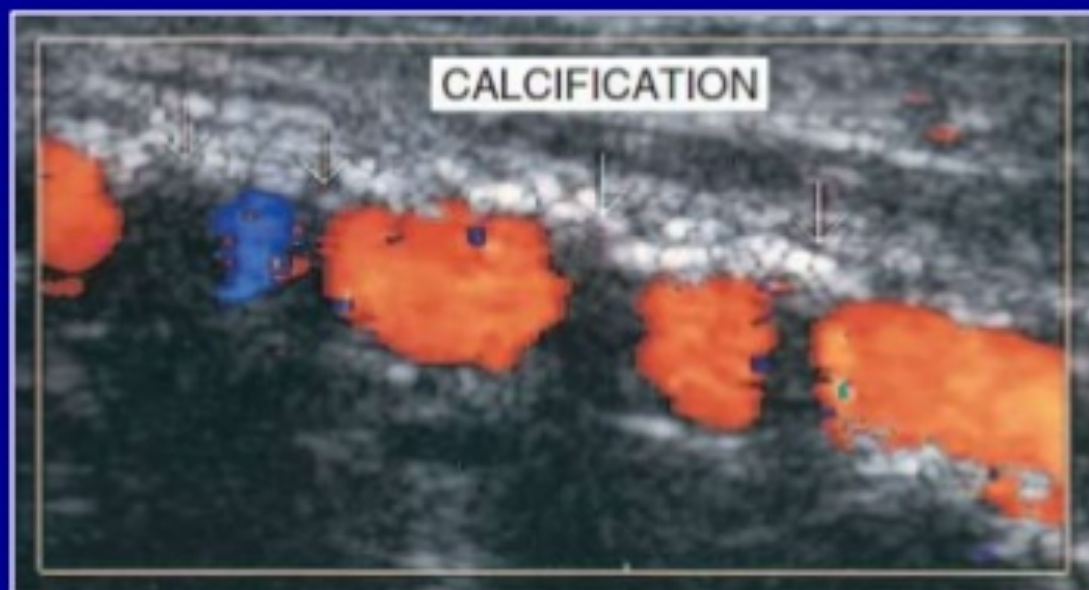


2 severe stenoses demonstrated in SFA

Areas of color flow disturbance & aliasing (arrows)

Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.  
Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

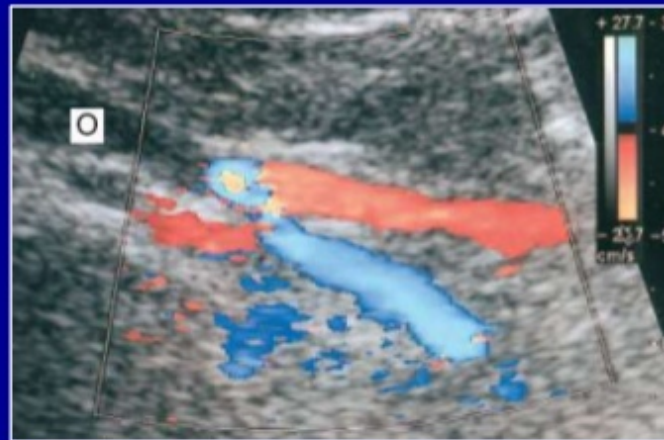
## Calcified atheroma in SFA



Drop-out of color flow signal in parts of lumen

Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.  
Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

## Occlusion of the CIA

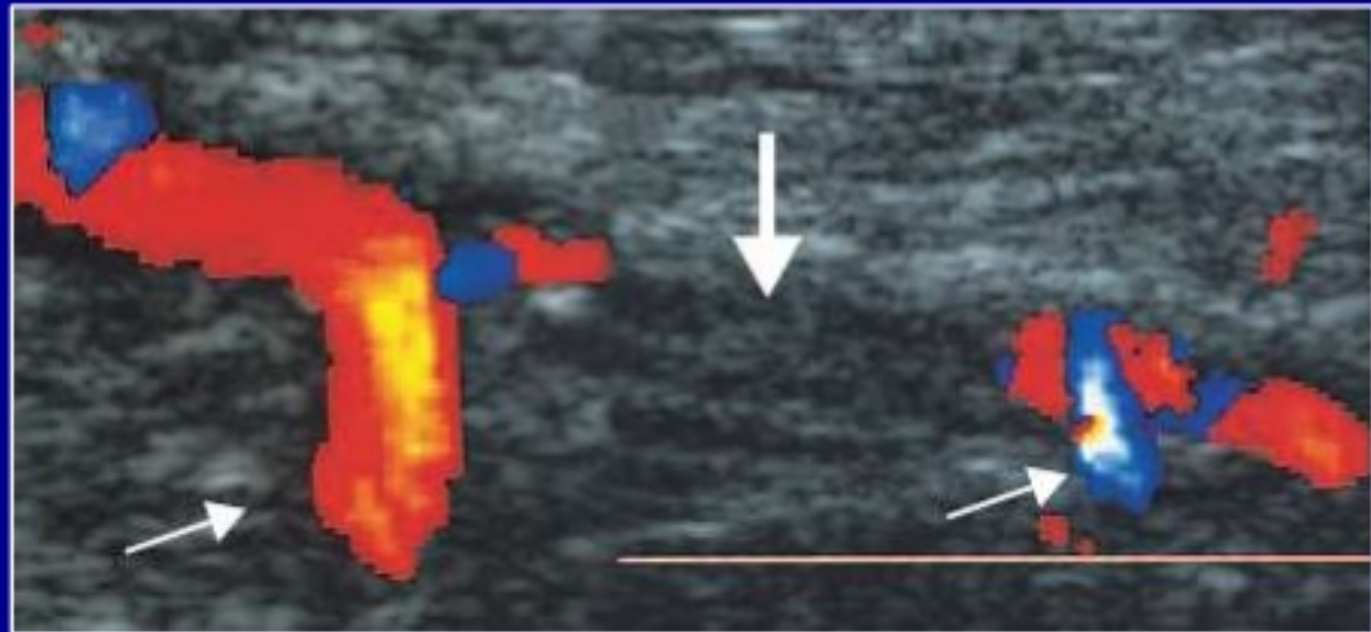


Occlusion in CIA

Reversed flow in IIA (blue) to supply flow to EIA (red)

Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.  
Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

## Arterial occlusion & collaterals



Short occlusion of mid-SFA (large arrow)

Large collateral at both ends of occlusion (small arrows)

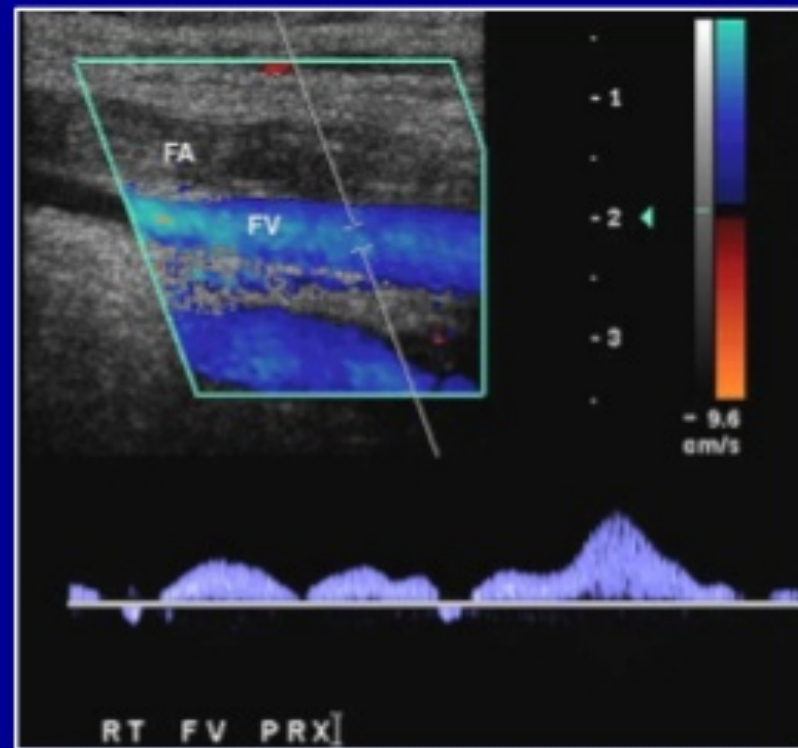
Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.  
Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

# Diagnostic reliability of peripheral arterial disease

## Systematic review – DSA as gold standard

|                                      | <b>MRA</b>           | <b>CTA</b>          | <b>CDUS</b>       |
|--------------------------------------|----------------------|---------------------|-------------------|
| <b>No of studies</b>                 | 6                    | 5                   | 7                 |
| <b>Sensitivity</b><br>Median (range) | 94%<br>(85 – 100)    | 97%<br>(89 – 100)   | 90%<br>(74 – 94)  |
| <b>Specificity</b><br>Median (range) | 99.2%<br>(97 – 99.8) | 99.6%<br>(99 – 100) | 99%<br>(96 – 100) |

# Thrombosis or embolism / Femoral artery



FA lumen filled with hypoechoic thrombus or embolus

Good delineation of vessel wall without signs of plaque

Normal flow in adjacent FV

# Definition of aneurysm & ectasia

## **Aneurysm**

Diameter increase  $> 50\%$  of normal expected diameter

## **Ectasia**

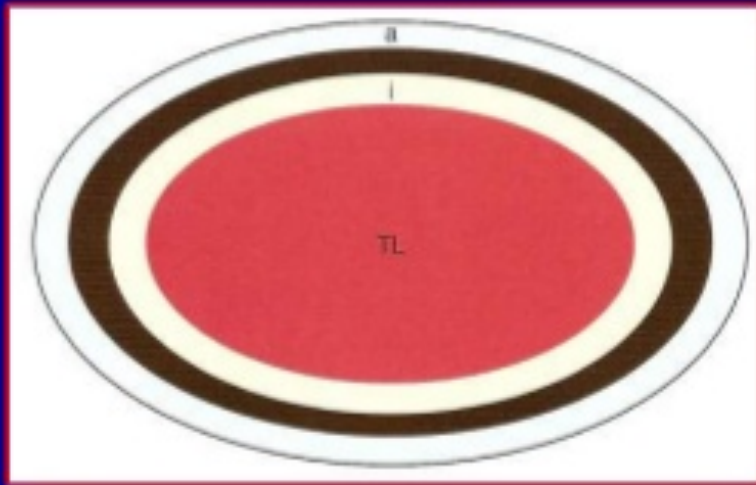
Diameter increase  $< 50\%$  of normal expected diameter

**Considerable variability in normal diameter of arteries**

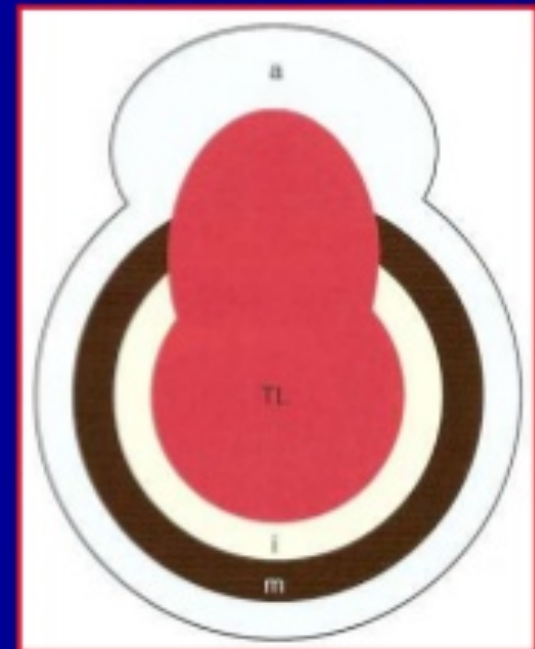
**Depends on physical size, sex, & age**

# Types of aneurysm

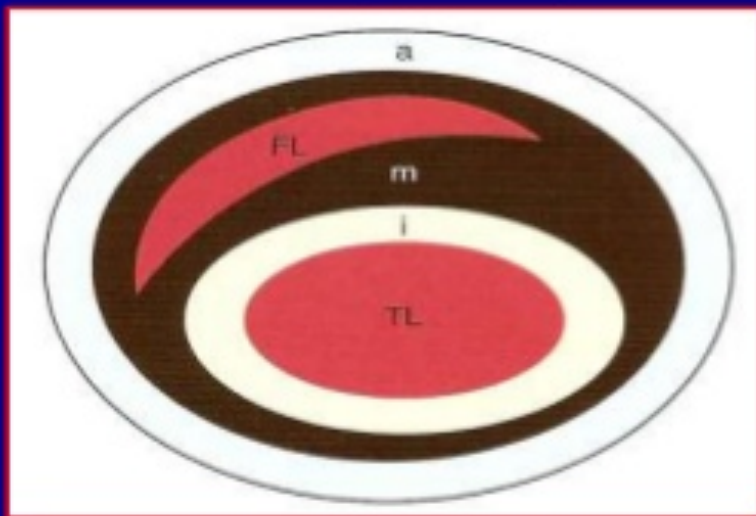
**True aneurysm**



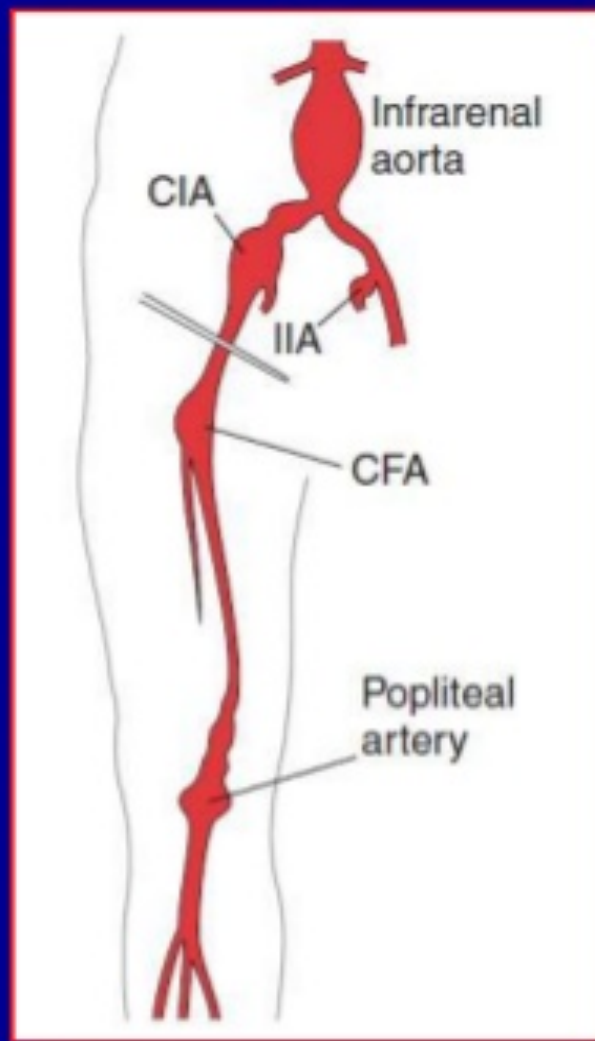
**False aneurysm**



**Dissecting aneurysm**

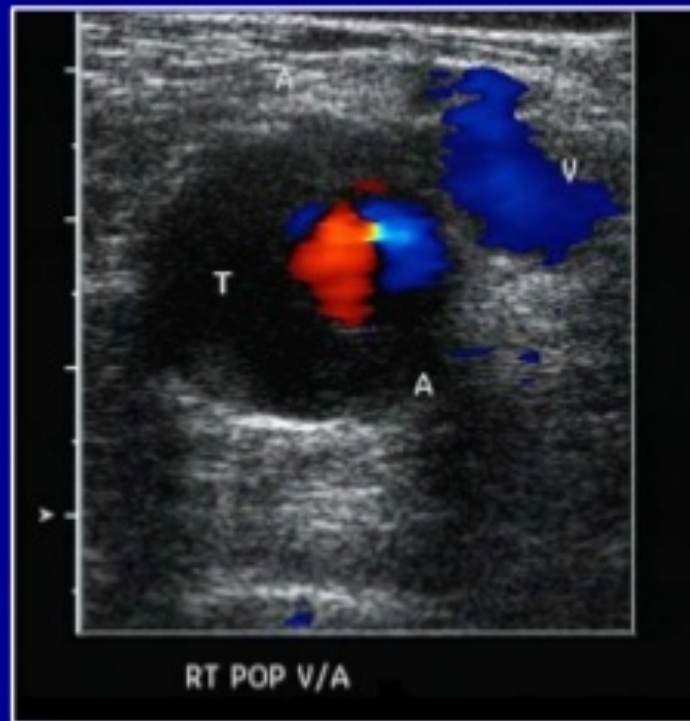


# Common sites for lower limbs aneurysms

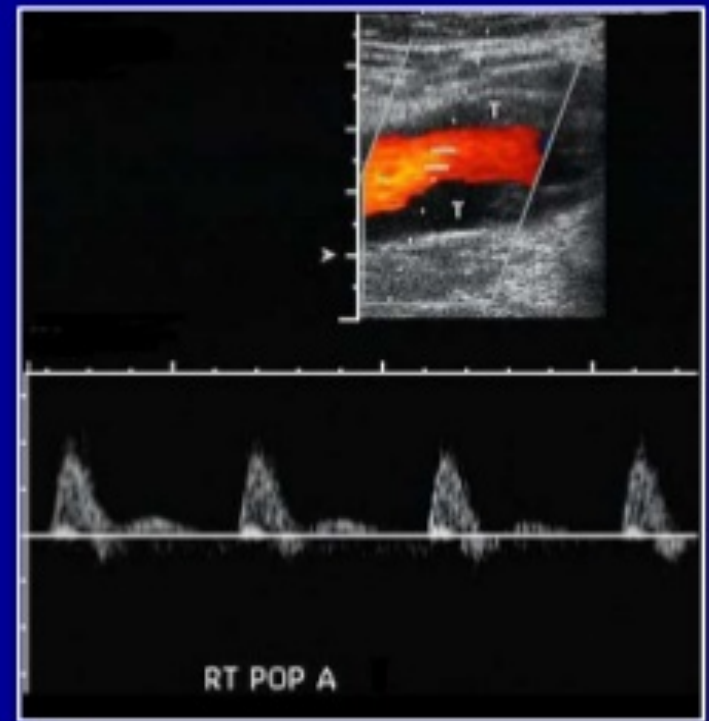


# Popliteal artery aneurysm / Partial thrombosis

Transverse CDUS



Sagittal pulsed & CDUS



Most common peripheral aneurysm

70% of peripheral aneurysms

# Cause di malattie arteriose

Aterosclerosi (causa più frequente)

Trombosi e embolia

Aneurisma

Dissezioni

Pseudoaneurisma

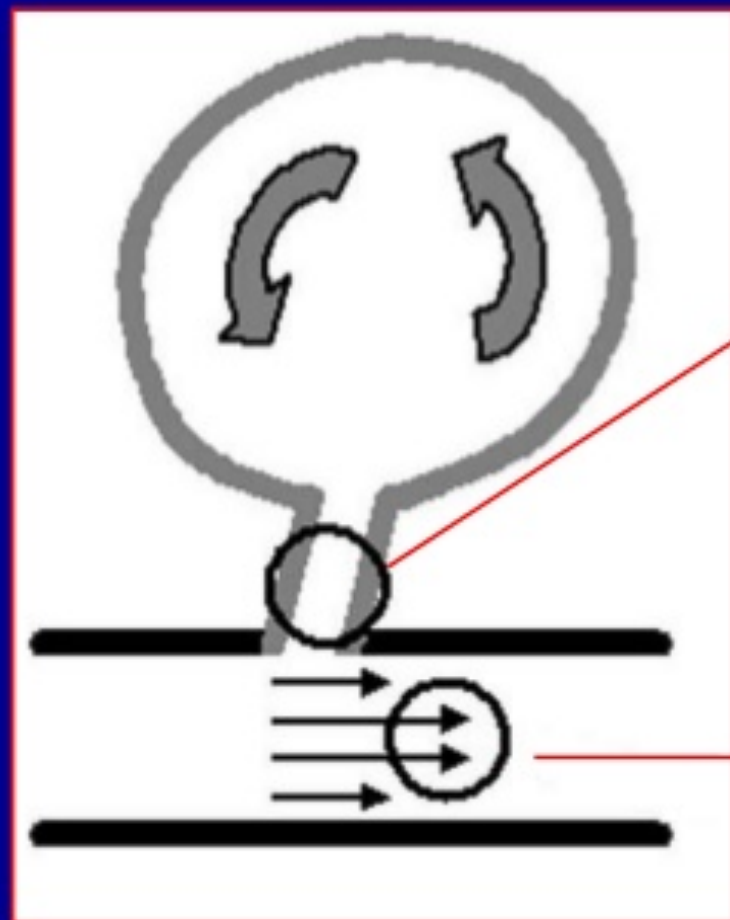
Fistola arterovenosa

Arteriti

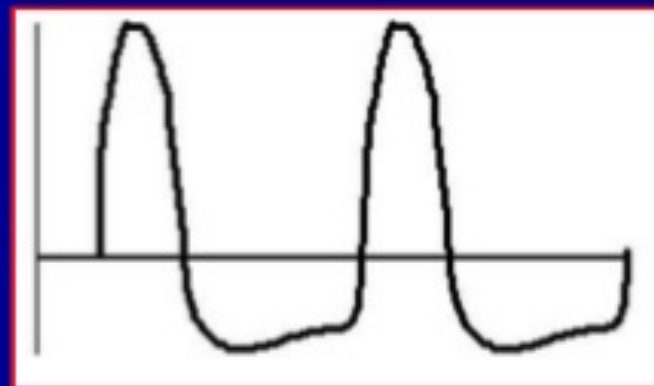
Sindrome da intrappolamento

Cisti dell'avventizia

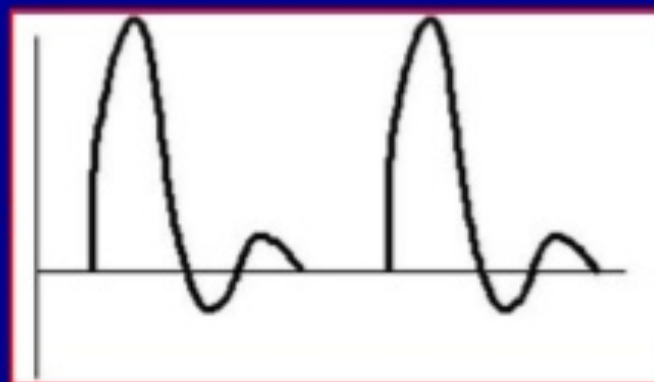
# Pseudo-aneurysm



**To-and-fro flow**



**Typical triphasic flow**



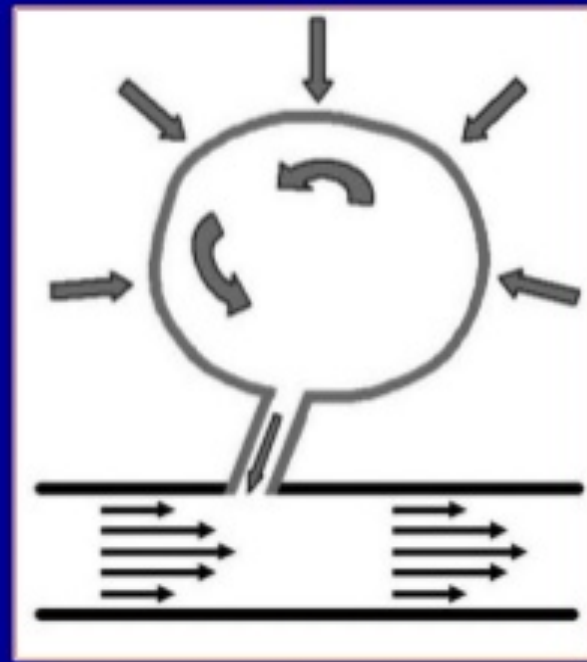
# Pseudo-aneurysm / “to-and-fro” flow

During systole  
“to”



Flow enters PA via the neck  
Pseudo-aneurysm lumen enlarges

During diastole  
“fro”



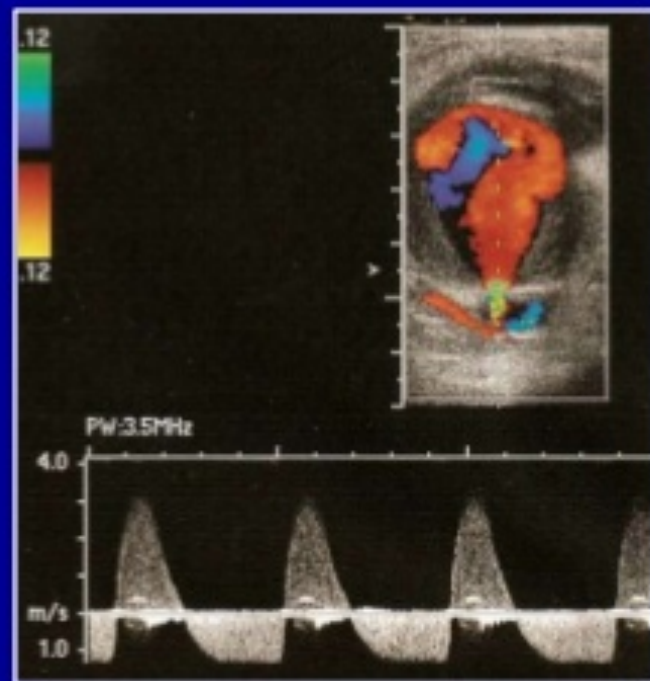
Flow exits PA via the neck  
Pseudo-aneurysm lumen contracts

# Pseudo-aneurysm / CFA

2 – 4% of cases after catheter intervention



Large perivascular  
fluid collection

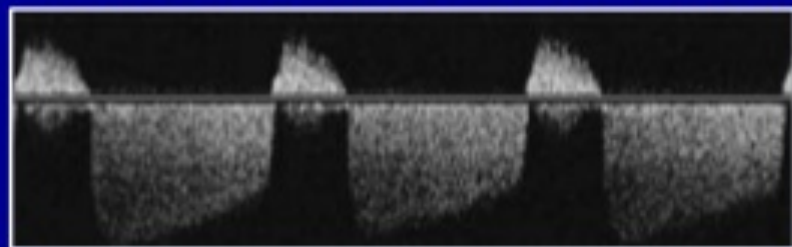


Color Doppler: **swirling pattern**  
**“yin-yang” pattern**

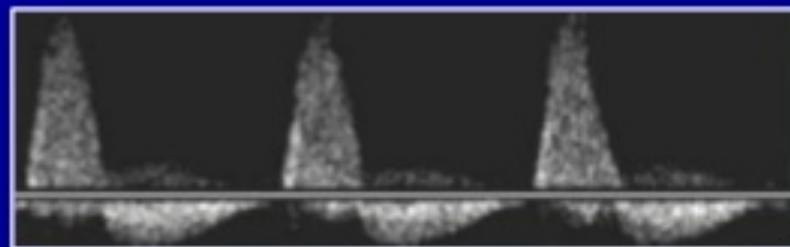
Pulsed Doppler: **“to-and-fro” flow**  
**classic pattern**

# Pseudoaneurysm / Variations in “to-and-fro” flow

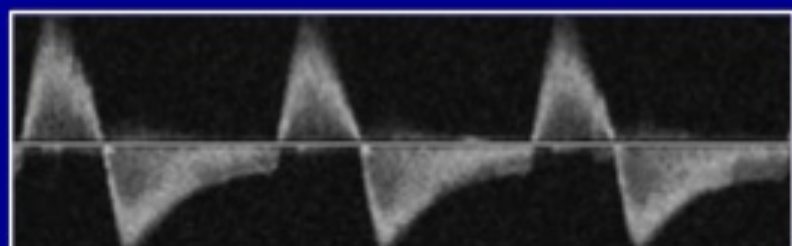
Limited systolic flow  
More pronounced diastolic flow



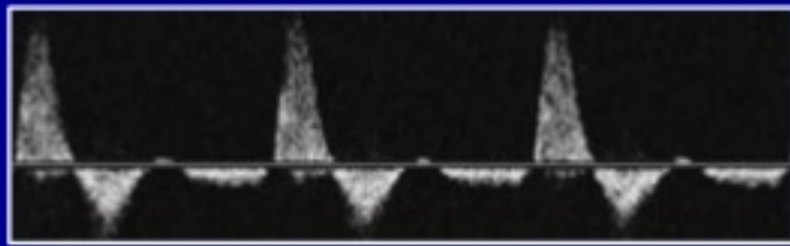
Diastolic flow relatively limited



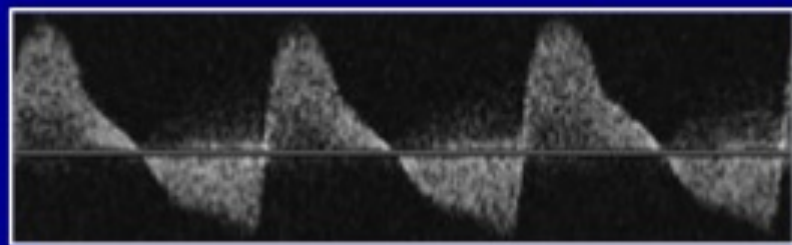
Diastolic flow decreases progressively



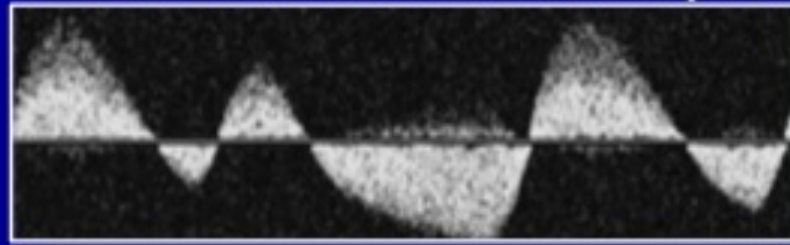
Two distinct phases of diastolic flow



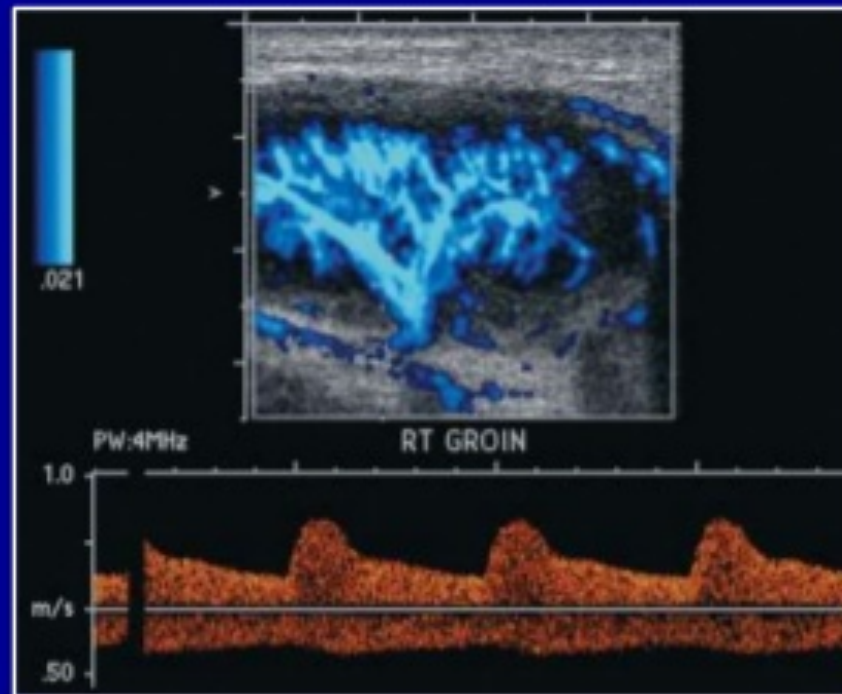
Diastolic flow increases progressively



Variations in duration & velocities of  
systolic & diastolic flow due to arrhythmia



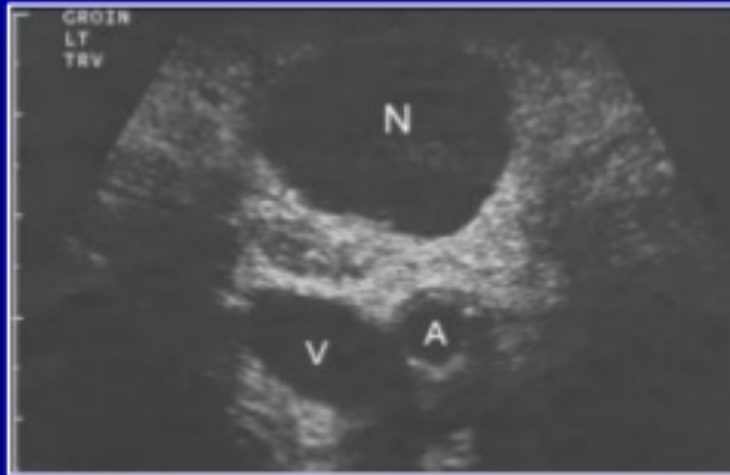
# Pseudo-aneurysm / Differential diagnosis



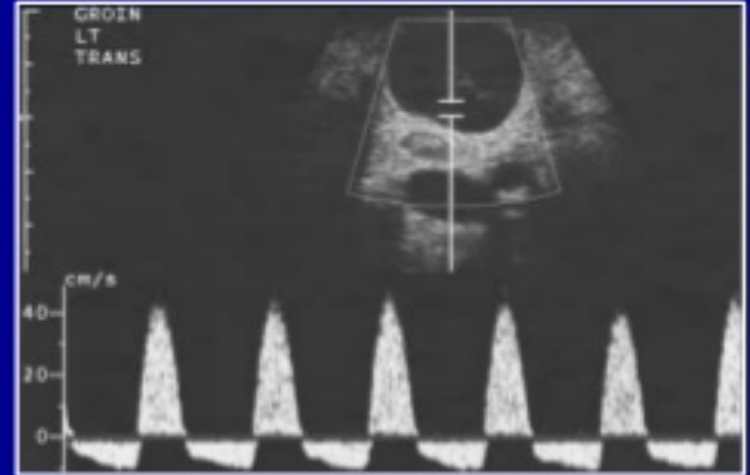
Arborizing flow in enlarged inguinal LN mistaken for PS  
Low-resistance arterial flow with continuous diastolic flow  
Venous flow below baseline

# Pseudo-aneurysm / Differential diagnosis

Inguinal LN from melanoma



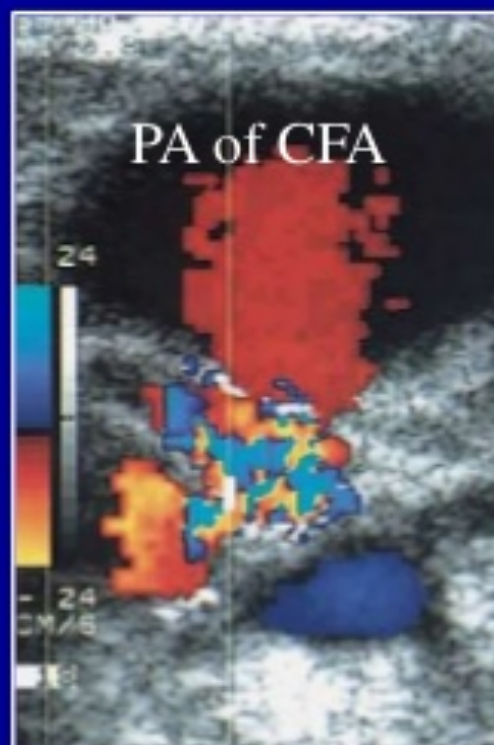
“to and fro” pattern near base of LN



Vessels at base of LN different from pattern seen in PA

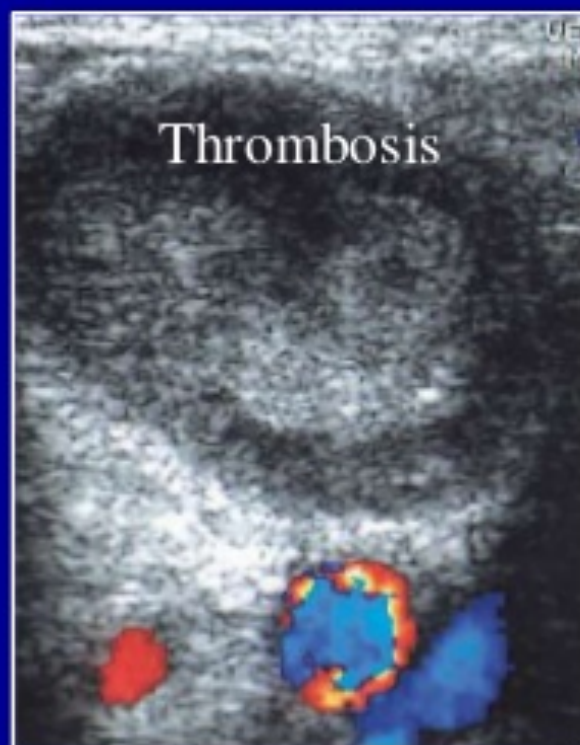


# Pseudo-aneurysm / US-guided compression



Marked perivascular tissue  
vibration associated with arterial jet

US guided  
compression



Pseudoaneurysm  
successfully thrombosed

Thrush A, Hartshorne T. Peripheral vascular ultrasound: How, why and when.  
Elsevier Churchill Livingstone, London, 2<sup>nd</sup> edition, 2005.

# Grazie per l'attenzione

**Algunas personas  
causan felicidad a  
donde van; otras,  
cuando se van**

Oscar Wilde

