

# Diabetic Foot Ulcer : Role of Vascular Surgeon

Practical Point in Diabetic Foot Care  
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# Misunderstood about Diabetic Foot Ulcer Management

- We think that diabetic ischemic ulcer is microvascular disease.
- We think DM ischemic ulcer should have PAD symptoms before.
- We think DM ulcer cannot be treated.

# Diabetic Foot Ulcer

## Three components interplay

1. Neuropathy

2. Infection

3. PAD (ischemia)

- Strongest prognostic indicator for non-healing ulcer
- Strongest risk of amputation & death

# Signs & Symptoms (problems)

1/3 have ischemic symptoms before

- Neuropathy
- Infection

40% have not investigated for PAD at all

1/2 amputated patients have no vascular assessment before.

Delayed revascularization

→ Worse outcomes and higher amputation/ mortality

# DFUs associated with PAD in Thai Population

## Delayed in diagnosis & treatment Consequence

- ↓ Possibility of revascularization
- ↑ Major amputation & Mortality

*SOURCE : Thai Vascular Association*

# Major Symptoms of PAD

Patients with PAD have a reduced functional capacity that limits their ability to perform daily activities.

## Abnormal skin color

Skin (of extremities) turns to a pale or purple color. Numbness sometimes appears together.



## Coldness

Cold sensation in one or both legs/hands



## Rest pain

Occlusion of the lumen of 90% or more will likely produce pain even at rest .



## Claudication

Pain in one or both legs on walking, primarily affecting the calves, that does not go away with continued walking and is relieved by rest



## Other symptoms

Erectile dysfunction  
Peripheral Neuropathy

<i>Condition</i>	<i>Location</i>	<i>Prevalence</i>	<i>Characteristic</i>	<i>Effect of exercise</i>	<i>Effect of rest</i>	<i>Effect of position</i>	<i>Other characteristic</i>
Calf IC	Calf muscles	3% of adult population	Cramping, aching discomfort	Reproducible onset	Quickly relieved	None	May have atypical limb symptoms on exercise
Thigh and buttock IC	Buttocks, hip, thigh	Rare	Cramping, aching, discomfort	Reproducible onset	Quickly relieved	None	Impotence. May have normal pedal pulses with isolated iliac artery disease
Foot IC	Foot arch	Rare	Severe pain on exercise	Reproducible onset	Quickly relieved	None	Also may present as numbness
Chronic compartment syndrome	Calf muscles	Rare	Tight, bursting pain	After much exercise (jogging)	Subsides very slowly	Relief with elevation	Typically heavy muscled athletes
Venous claudication	Entire leg, worse in calf	Rare	Tight, bursting pain	After walking	Subsides slowly	Relief speeded by elevation	History of iliofemoral deep vein thrombosis, signs of venous congestion, edema
Nerve root compression	Radiates down leg	Common	Sharp lancinating	Induced by sitting	Often present at rest	Improved by change in position	History of back problems
Symptomatic Baker cyst Hip arthritis	Behind knee, down calf Lateral hip, thigh						
Spinal stenosis	Often bilateral buttocks, posterior leg						
Foot/ankle arthritis	Ankle, foot, arch						

## Ischemic Claudication

: Typical leg symptoms

- Cramping/aching/discomfort

- Reproducible onset & Quickly relieved

JVS 2015;61:2S-41S

exercise

weight

activity level  
and present at  
rest

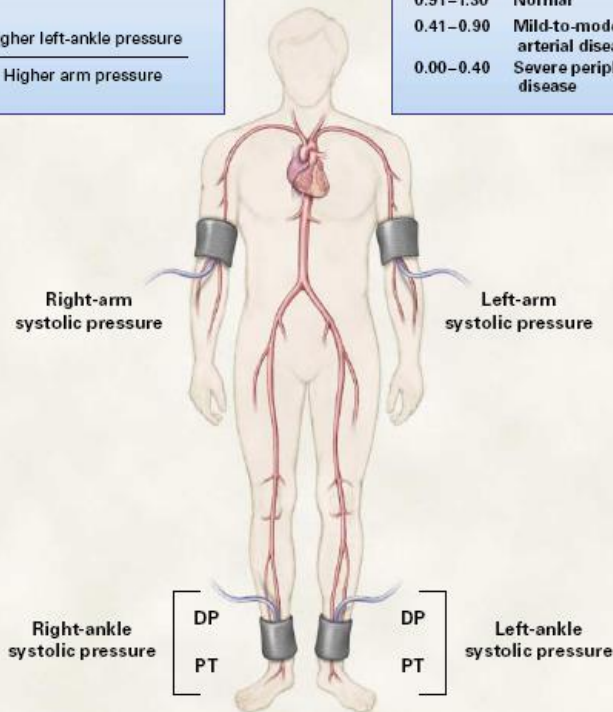
# Investigations (problems)

Non-compressible vessels due to calcified vessel wall  
- ABI can be false elevated

<b>Right ABI</b>	$\frac{\text{Higher right-ankle pressure}}{\text{Higher arm pressure}}$
<b>Left ABI</b>	$\frac{\text{Higher left-ankle pressure}}{\text{Higher arm pressure}}$

Interpretation of ABI	
> 1.30	Noncompressible
0.91–1.30	Normal
0.41–0.90	Mild-to-moderate peripheral arterial disease
0.00–0.40	Severe peripheral arterial disease



## Interpretation of ABI

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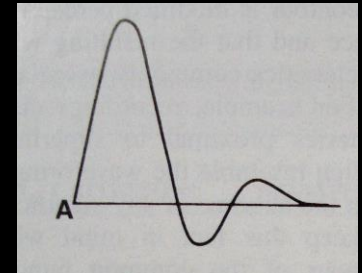




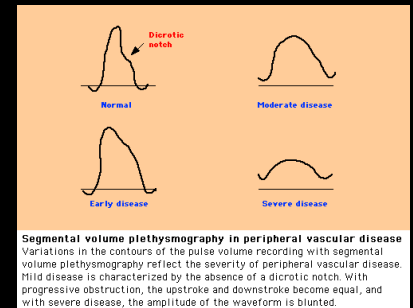
# Arterial wall calcification

- : Non-compressible
- : False elevated ankle pressure
- : Need alternative measurements

## Waveform analysis

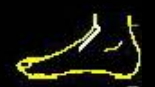
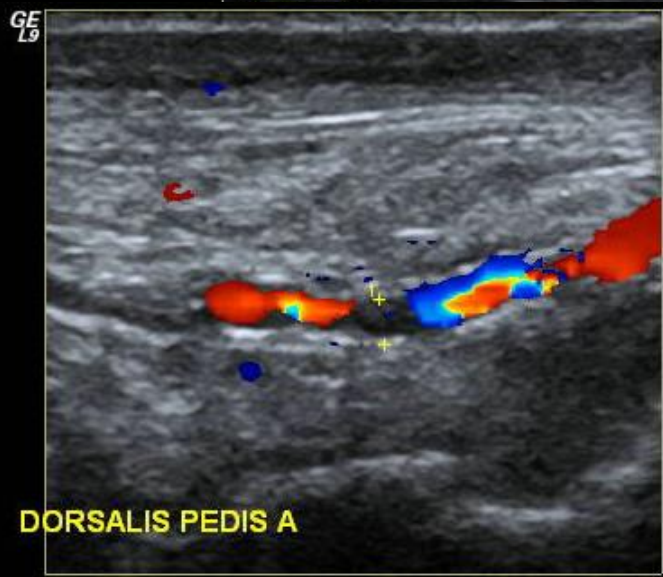
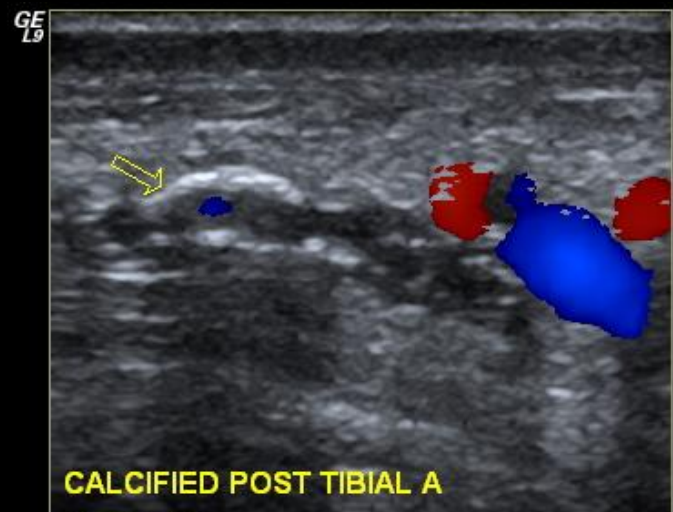
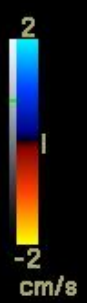


## Volume Plethysmography



## O2 measurement





40 VOl  
N 120  
mA 352  
Rot 0.90s/HE+ 20.6mm/rot  
1.2mm 0.516 1/1 Osp  
TR 0.0  
17.26.58.000

0.18 cm

# Peripheral Artery Disease : Diagnosis

History taking

- Walking problem
- Back pain

Physical examination

- Sign of chronic PAD
- Pulse exam.



# Critical Limb Ischemia

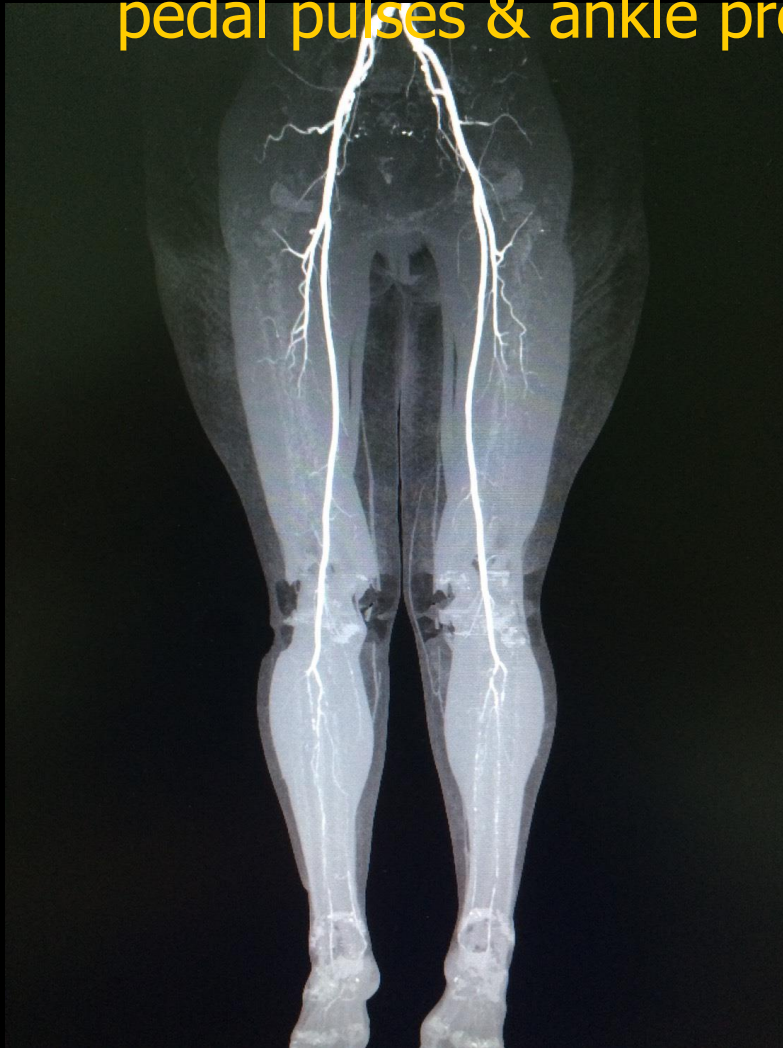
Inadequate arterial blood flow to accommodate the metabolic needs of resting tissue

- Rest pain, Gangrene & Ulcer
- Ankle systolic pressure  $<50$  mmHg
- Toe systolic pressure  $<30$  mmHg



TASC II, Consensus on PAD 2007

A 48-year-old female presents a chronic claudication on her feet for several months. Physical Exam. – absent bilateral pedal pulses & ankle pressure 50 mmHg



# Treatment of PAD

- Asymptomatic PAD
- Intermittent claudication Ankle pressure >50 mmHg  
→ Exercise & Medical treatments
- Critical limb ischemia Ankle pressure <50 mmHg  
→ Medical treatments  
→ Revascularization

# Exercise Therapy for PAD

- : Cornerstone in claudication
- : Increase the walking distance, 50-200% roughly.
- : Patient-specific limitation

## Mechanism

- Enlargement of existing collateral vessels
- Exercise induced angiogenesis
- Enhanced NO endothelium-dependent vasodilatation of the microcirculation
- Improved bioenergetics of skeletal muscle
- Improved hemorrheology

# Exercise vs Stenting for Claudication

Six-Month Outcomes From the Claudication: Exercise Versus Endoluminal Revascularization [\(CLEVER\) Study](#)

## Symptomatic AIOD

Peak walking time → 2-11 min

## Rx conditions →

Medical Rx(OMC), Exercise (SE), Stenting (ST)

## End points

Primary- Peak Walking Time

*Circulation 2012*



# Exercise vs Stenting for Claudication

Six-Month Outcomes From the Claudication: Exercise Versus Endoluminal Revascularization ([CLEVER](#)) Study

## Results

PWT improved by

1.2 $\pm$ 2.6 minutes in Medical Rx group

**5.8 $\pm$ 4.6 minutes in Exercise group**

3.7 $\pm$ 4.9 minutes in Stenting group

*Circulation 2012*

**Cilostazol** is a phosphodiesterase inhibitor with vasodilator and antiplatelet properties.

Improves maximal walking distance 40-60% after 3-6 months of therapy. (100mg orally 2 times a day)

**Cilostazol increases NO in endothelial cell**

Vascular smooth muscle cells relaxation  
Peripheral vascular bed dilatation

JVS 2007

# Role of Revascularization for Claudication

: <5% of the IC patients will develop symptoms of advanced ischemia → Benign

: Durable benefit of the revascularization Technique

## Indications

Significant functional limiting disability

Asymptomatic AIOD for provide vascular access for another cardiovascular implant

# Treatment of PAD

- Critical limb ischemia Ankle pressure <50 mmHg

→ Revascularization

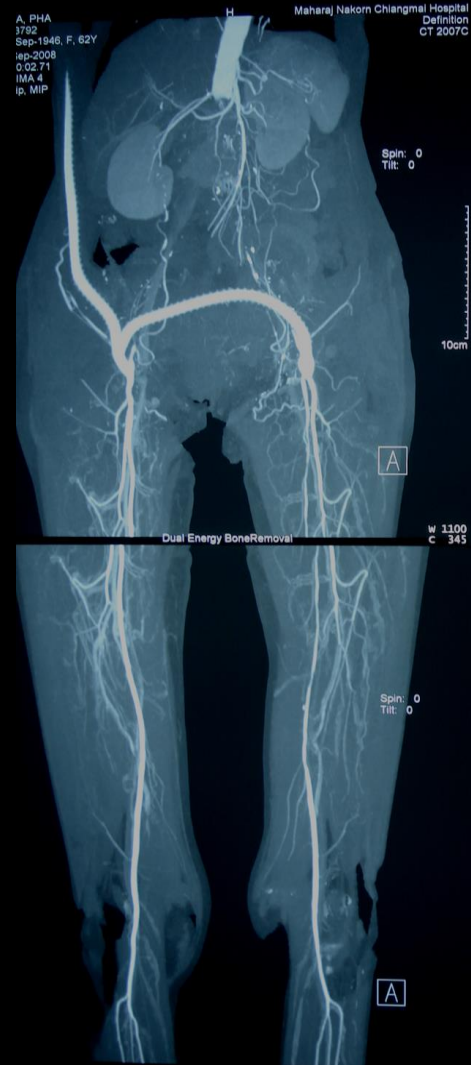
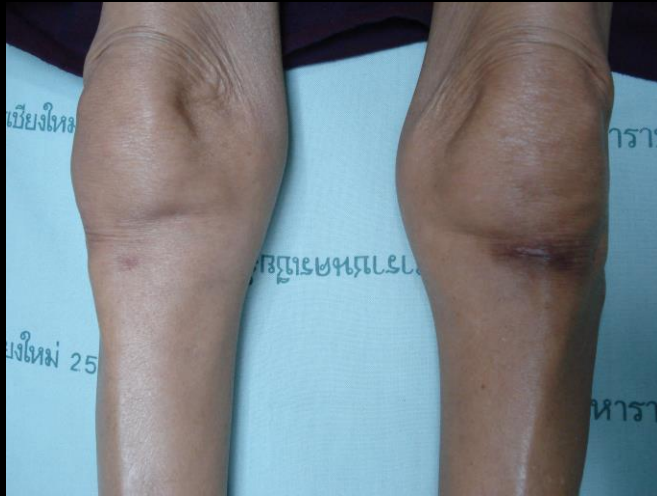
Open surgery

Low surgical risk, diffuse disease

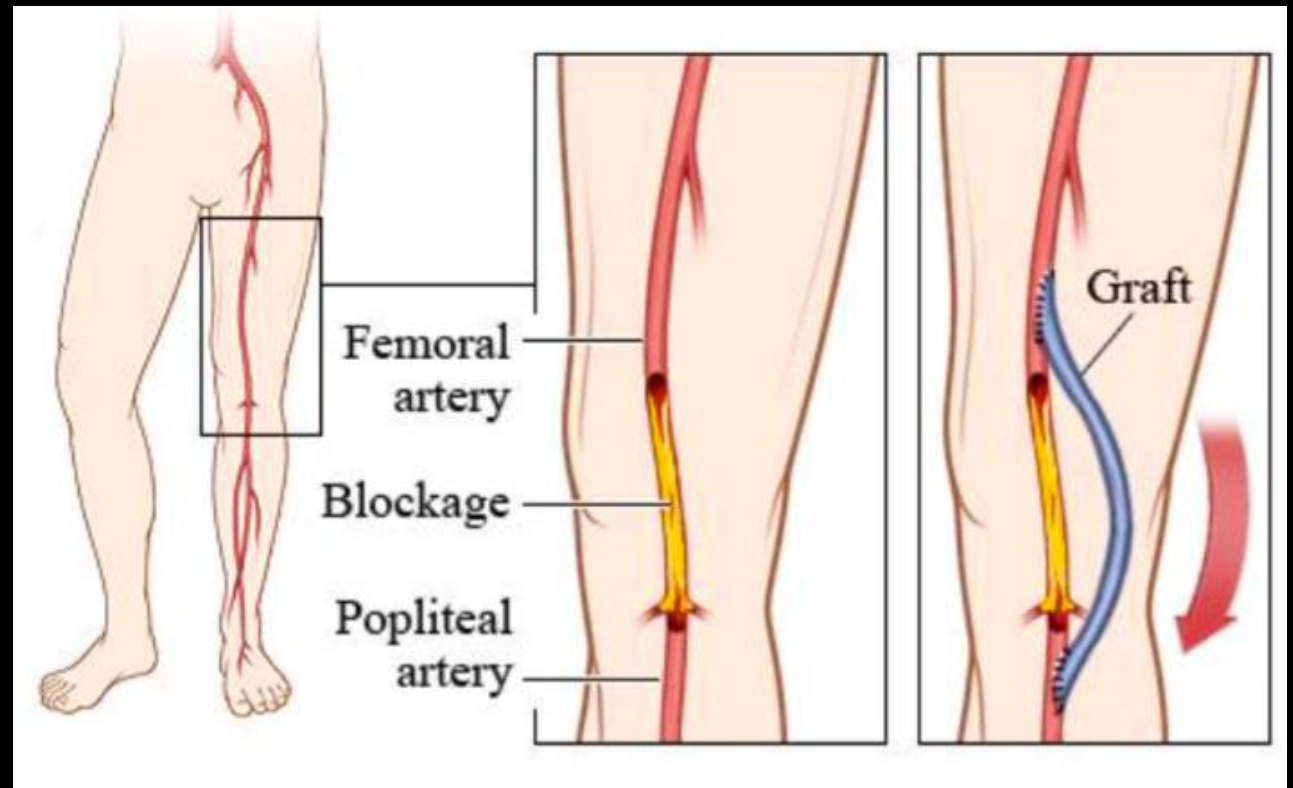
Endovascular surgery

High surgical risk, focal disease

# Axillo-bifemoral Bypass



# Femoro-popliteal Bypass



A 72-year-old male presents with ischemic ulcer on his right

1<sup>st</sup> toe for several months. Physical Exam. – absent popliteal pulses & ankle pressure 30 mmHg (R)



Im:10  
DERIVED\SECONDARY  
512x512

MAHAHAJ NAKURN CHIANGMAI  
RALUEKPRAIPANA BOEBLA  
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Acc:46992  
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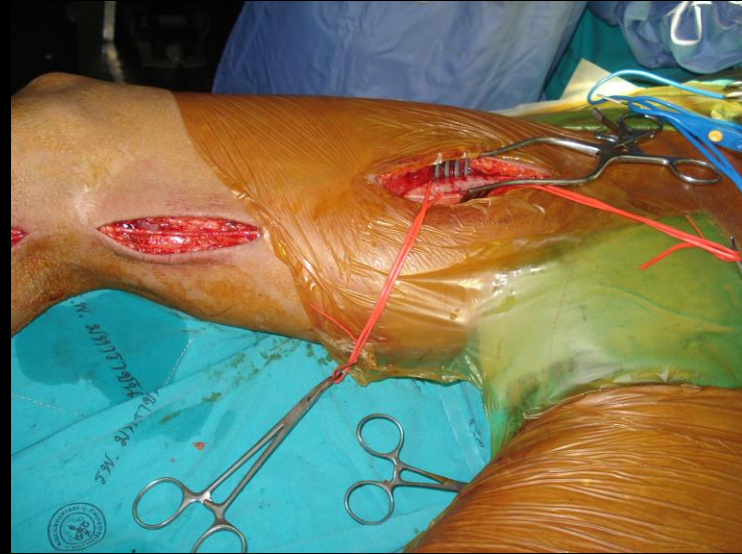
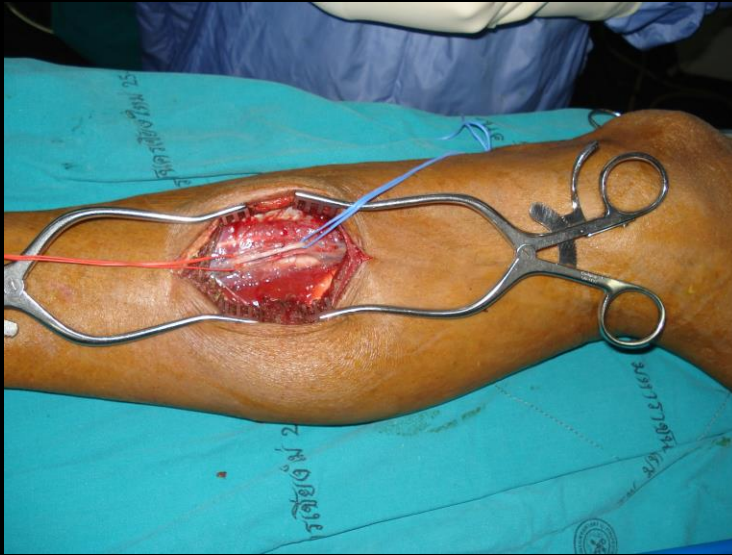
kVp:120 mA:250 ms:500

512x512x721 Transverse  
(0.78x0.78x1.00mm)

C1  
Pos:FF!  
Individually captured image:

Voxar 3E

# Femoral-Posterior Tibial Artery Bypass





# Femoral-Posterior Tibial Artery Bypass

## Post-Operative Study

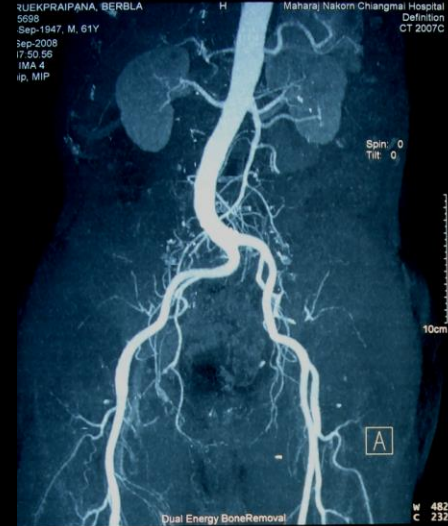
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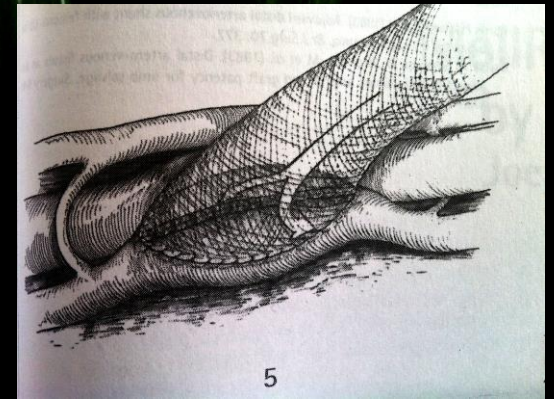
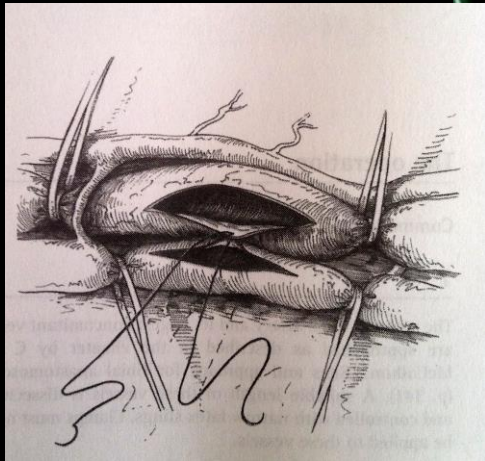


## Preoperative Study

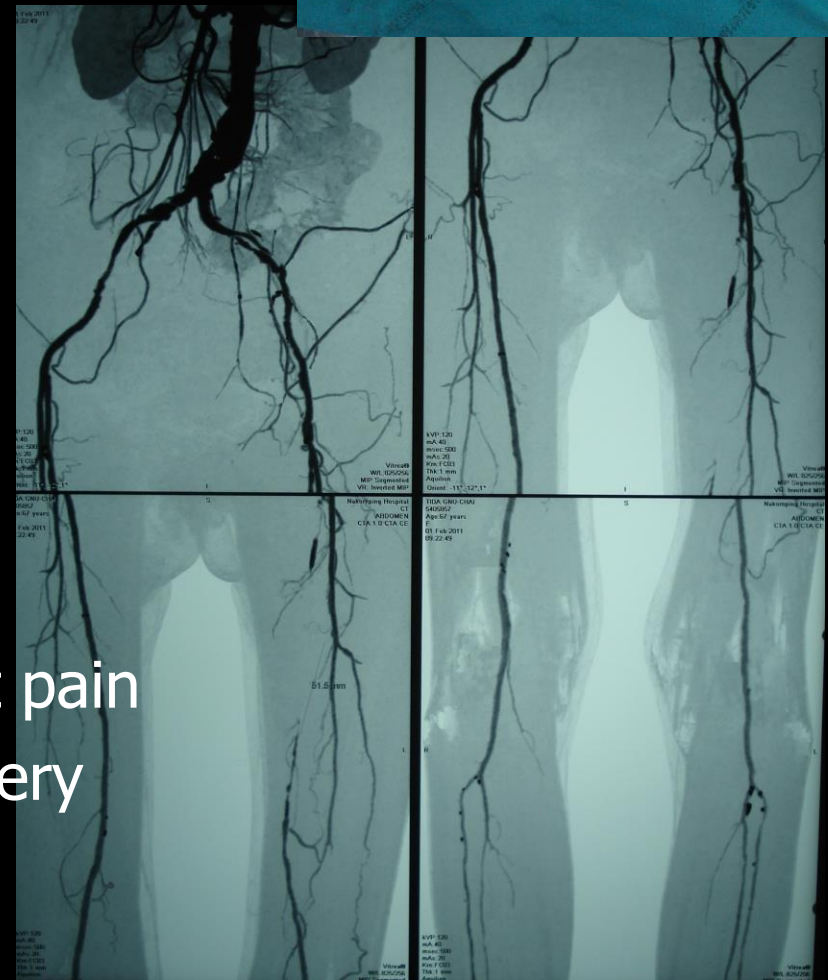
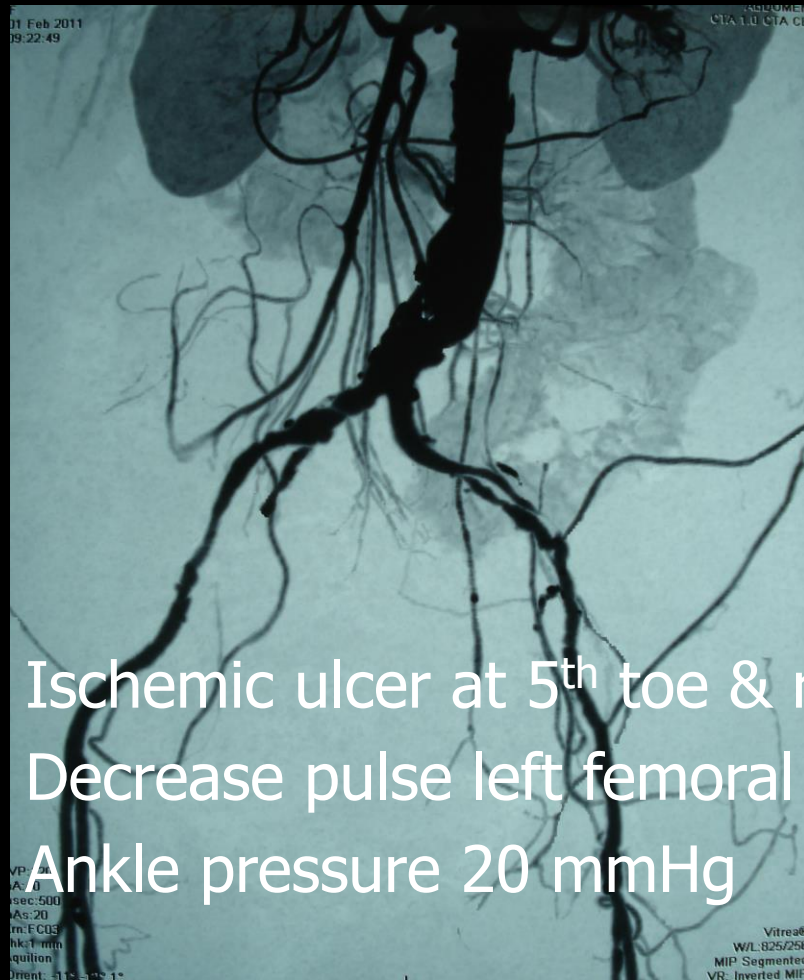
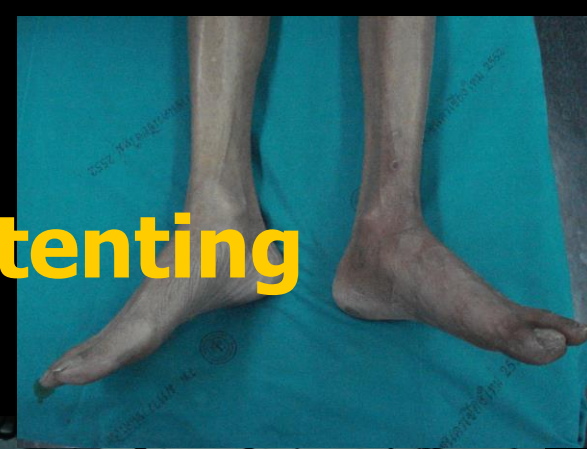
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ip, MIP



# Adjuvant distal AVF



# Iliac-femoral Artery : Angioplasty with primary stenting



Ischemic ulcer at 5<sup>th</sup> toe & rest pain  
Decrease pulse left femoral artery  
Ankle pressure 20 mmHg

# Iliac-femoral Artery : Angioplasty with Primary Stenting



Ankle pressure 60 mmHg

Ischemic ulcer & pain resolved

Fem-pop segment → No further treatment

# Femoropopliteal Artery : Angioplasty with Stenting



Known case CAD S/P CABG 4 months ago  
Ischemic ulcer at dorsum of R foot & rest pain  
Decrease pulse right popliteal artery  
Ankle pressure 0 mmHg

# Femoropopliteal Artery : Angioplasty with Stenting



Ischemic ulcer & pain improved  
Ankle pressure 50 mmHg



Ischemic ulcer at 1<sup>st</sup> toe & rest pain  
Decrease pulse right femoral artery  
Ankle pressure 50 mmHg

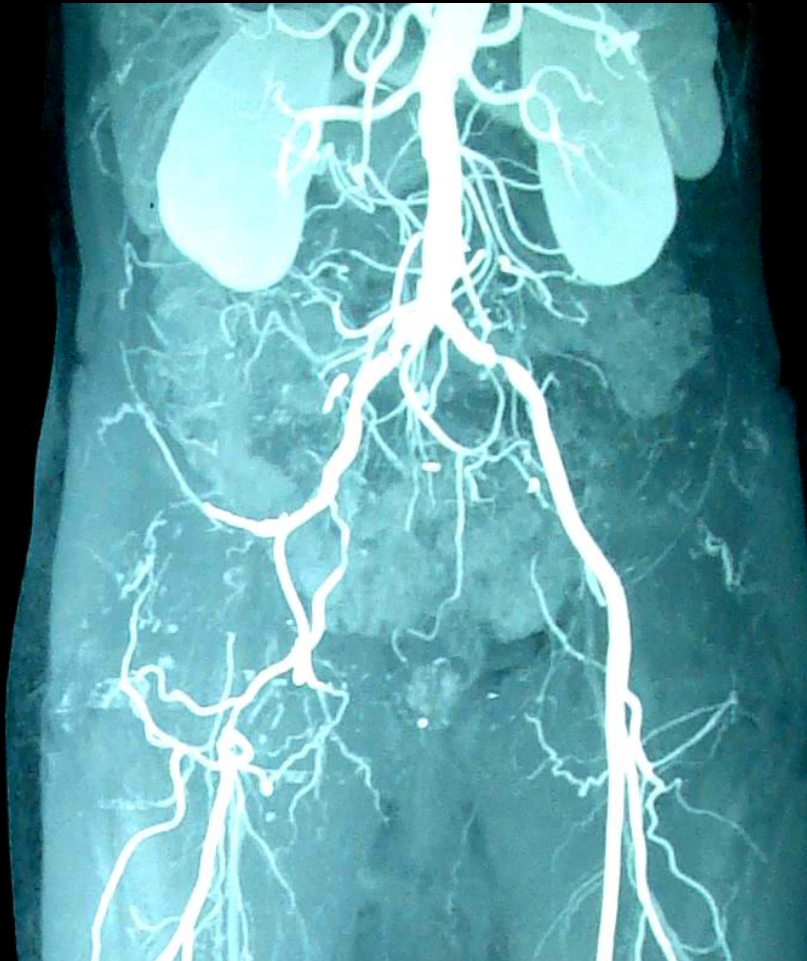




Ankle pressure 90 mmHg  
Ischemic pain resolved  
Metatarsal amputation



# Hybrid Vascular Reconstruction



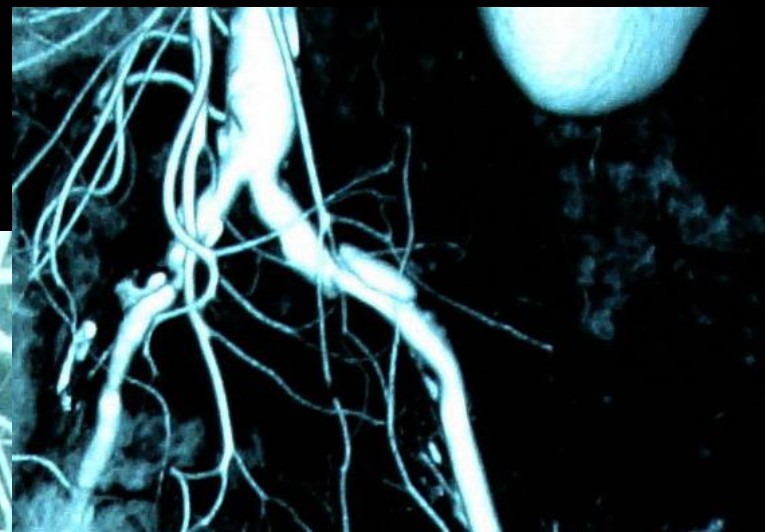
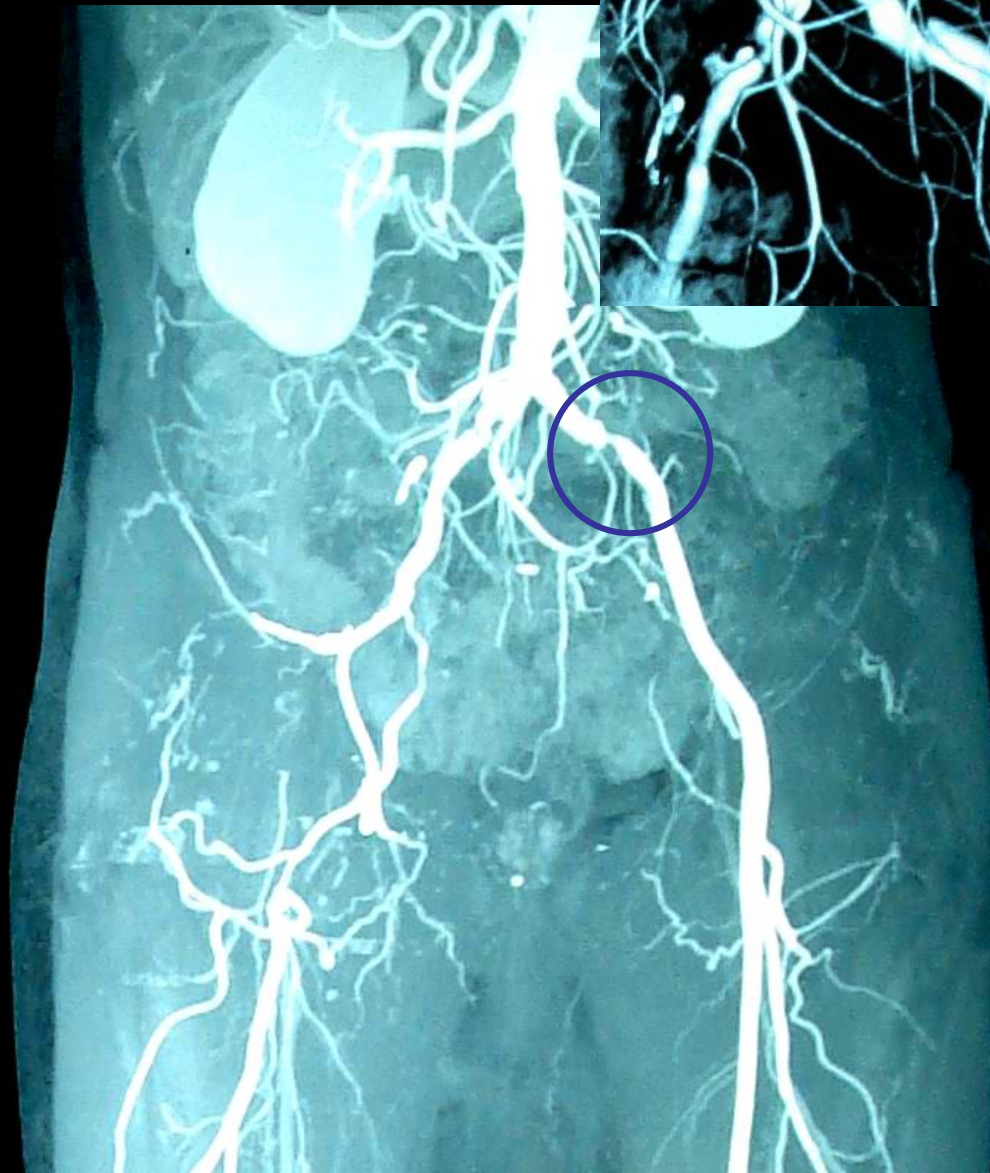
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v 120  
IA 251  
-at 0.60s/HE+ 20.6mm/rot  
2mm 0.516:1/1.0sp  
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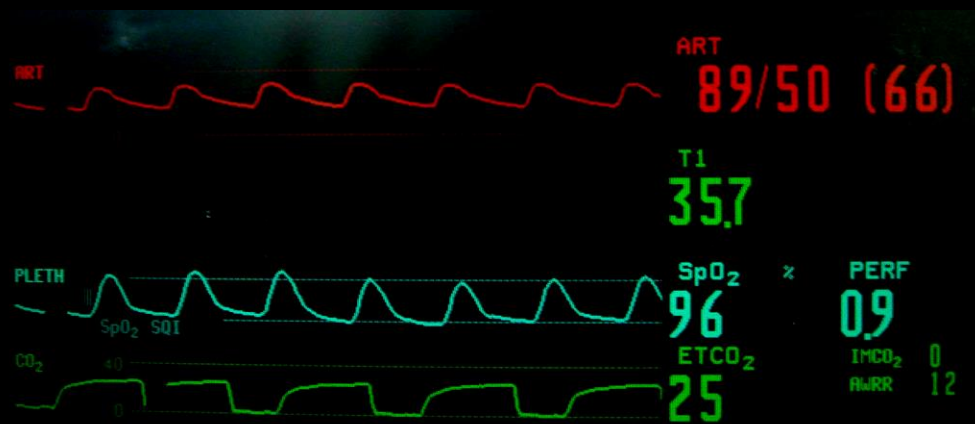


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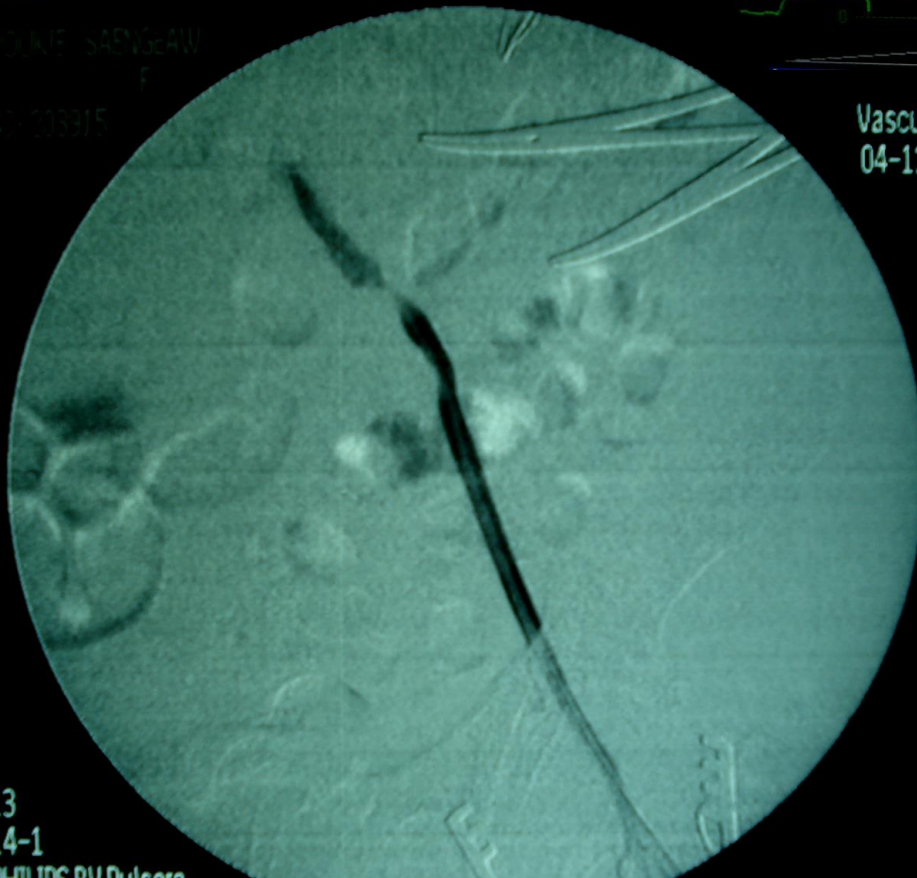
# Hybrid Vascular Reconstruction



# Hybrid Vascular Reconstruction



POKKE SAEVGEAW  
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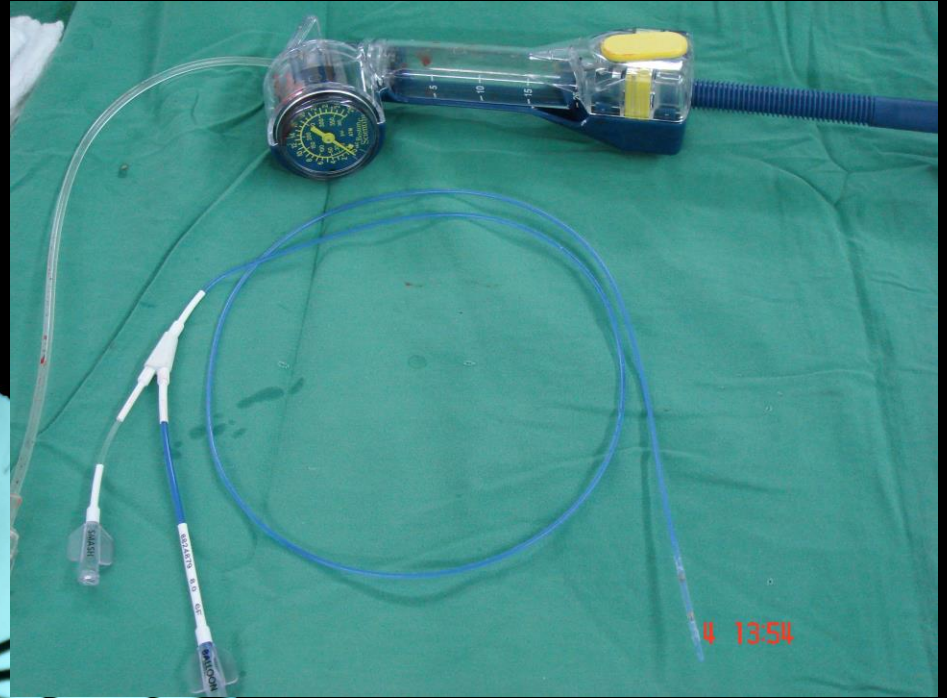
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Vascular abdominal  
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14-1  
NUM TDC DII Chumpol

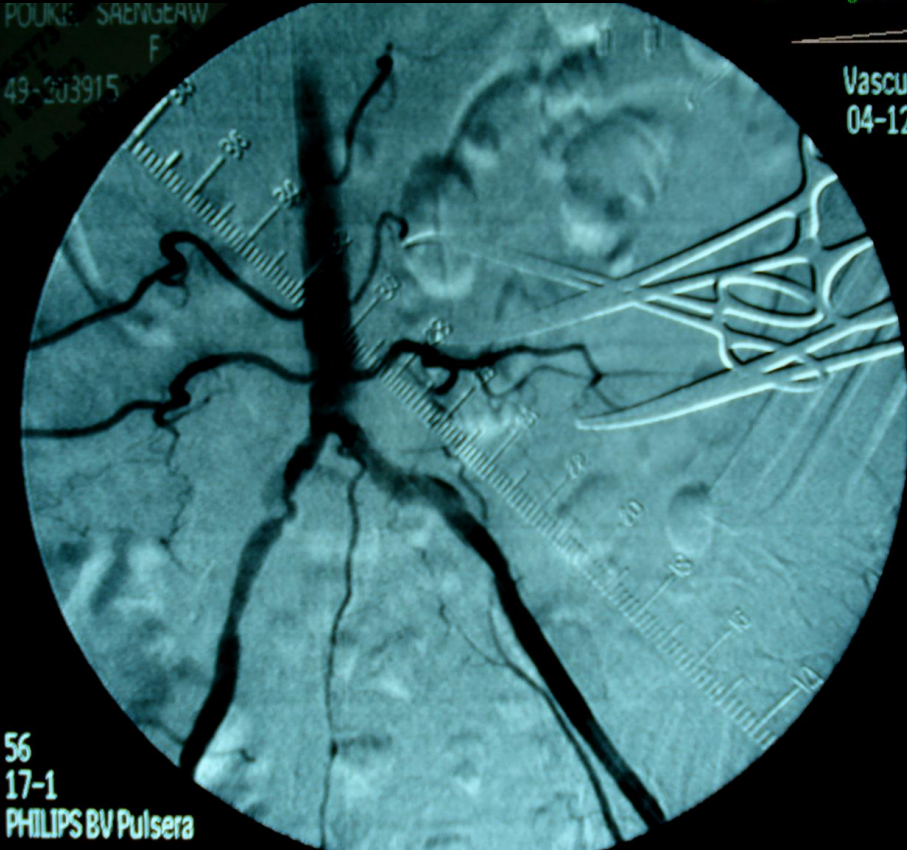
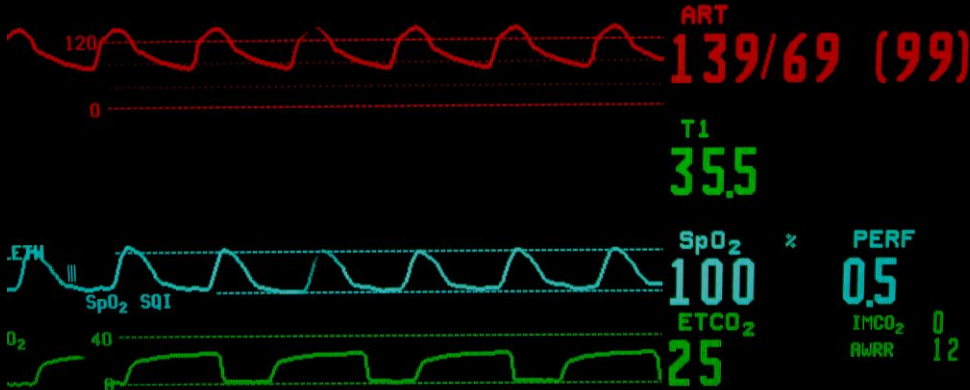
# Hybrid Vascular Reconstruction

POUKIE SAENGEAW



PHILIPS BV Pulsera

# Hybrid Vascular Reconstruction



Vascular abdominal  
04-12-2006 14:46

SUBTRACT

56  
17-1  
PHILIPS BV Pulsera

# Hybrid Vascular Reconstruction

e: 2 +c  
olume Rendering No cut

FOV 50.9cm  
TND+\*



No VOI  
kV 120  
mA 351  
Rot 0.60s/HE+ 20.6mm/rot  
1.2mm 0.516:1/1.0sp  
Tilt 0.0  
08:42:42 AM  
W = 4095 L = 2048

Dec 27 2006 HD MIP No cut

DFOV 50.9cm  
STND+\*



L  
R

No VOI  
kV 120  
mA 351  
Rot 0.60s/HE+ 20.6mm/rot  
1.2mm 0.516:1/1.0sp  
Tilt 0.0  
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W = 4095 L = 2048

# Morbidity after Infrainguinal Bypass for Claudication & Critical Ischemia

	First Year	3-5 Years
Time for healing	15-20 wk	—
Wound complications (%)	15-25	—
Persistent lymphedema (%)	10-20	Unknown
Graft stenosis (%)	20	20-30
Graft occlusion (%)	10-20	20-40
Major amputation (%)	5-10	10-20
Graft infection (%)	1-3	—
Perioperative death (%)	1-2	—
All death (%)	10	30-50

# Probability of Failure after Bypass : When the Clinical Condition Is Present at Presentation

<b>Predictor Variable</b>	<b>Probability of Failure (%)</b>	<b>Odds Ratio (95% CI)</b>
Impaired ambulation	58	6.4 (2.9-14.4)
Infrainguinal disease	46	3.9 (1.6-9.8)
ESRD	35	2.5 (1.2-5.4)
Gangrene	34	2.4 (1.5-4.0)
Hyperlipidemia	11	0.6 (0.34-0.93)

Taylor SM, et al. J Am Coll Surg 2007



# Key Points

- DM patients with vascular disease are associated with significant morbidity/mortality.  
Under-diagnosed  
Delayed proper treatment
- Revascularization is possible and should be considered as the main stay treatment in CLI.  
Endovascular Surgery  
Bypass Surgery

**Thank you for your attention**