MEET 2015
MULTIDISCIPLINARY EUROPEAN
ENDOVASCULAR THERAPY

Arterial status, angiosome, arterial calcifications: it is possible to plan treatment at BTK level ?

Mauro Gargiulo

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Policlinico S.Orsola-Malpighi, Bologna, Italy
Chief: Prof. Andrea Stella

Arterial status, angiosome, arterial calcifications: it is possible to plan treatment at BTK level ?

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Disclosure

Speaker name: **Mauro Gargiulo**

I have the following potential conflicts of interest to report:

X **Consulting: William Cook Europe, Medtronic Vascular Inc.**

☐ Employment in industry

☐ Shareholder in a healthcare company

☐ Owner of a healthcare company

☐ Other(s)

☐

I do not have any potential conflict of interest

Tibial Artery Angioplasty with Uncoated Balloon in CLI

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	n.	%
Limbs	249	100
▪ **Fontaine Stage**		
III	20	8
IV	229	**92**

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Validation of a diabetic wound classification system

Armstrong DG et al Diabetes Care 1998;21:855-859

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Stage \ Grade	0	I	II	III
A	Pre or post-ulcerative lesion	Non-infected, non-ischemic, superficial ulceration	Non-infected, non-ischemic, ulcer that penetrates to capsule or bone	Non-infected, non-ischemic, ulcer that penetrates to bone or deep
B	With infection	With infection	With infection	With infection
C	Without infection, With ischemia	Without infection, With ischemia	Without infection, With ischemia	Without infection, With ischemia
D	With infection, With ischemia	With infection, With ischemia	With infection, With ischemia	With infection, With ischemia

Tibial Artery Angioplasty with Uncoated Balloon in CLI

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	n.	%
Limbs	249	100
▪ **Fontaine Stage**		
III	20	8
IV	229	**92**
▪ **TUC Grade**		
< III	53	21.3
III	176	**70.7**
▪ **TUC Stage**		
C	70	28.1
D	159	**73.9**

Path of treatment of CLI

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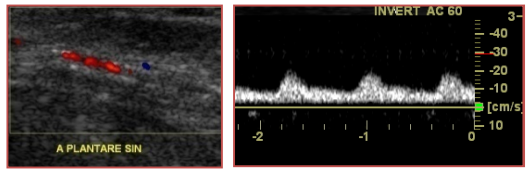
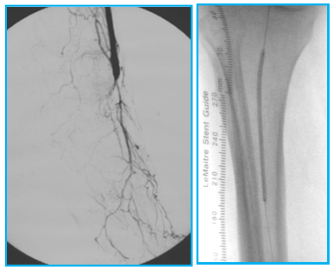
CLI

PAOD evaluation



Treatment of trophic lesions

Limb revascularization



Foot surgery
Treatment of trophic lesions
Adjuvant therapy

Limb salvage and Wound Healing

Treatment of trophic lesions
Functional rehabilitation

Ability to walk

To plan treatment at BTK level

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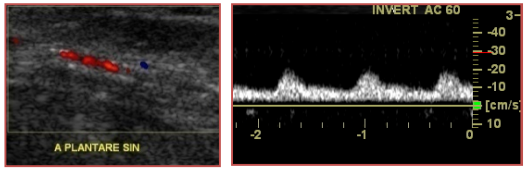
CLI

PAOD evaluation



Treatment of trophic lesions

Limb revascularization

Foot surgery
Treatment of trophic lesions
Adjuvant therapy

Limb salvage

Treatment of trophic lesions
Functional rehabilitation

Ability to walk

To plan treatment at BTK level – PAOD evaluation

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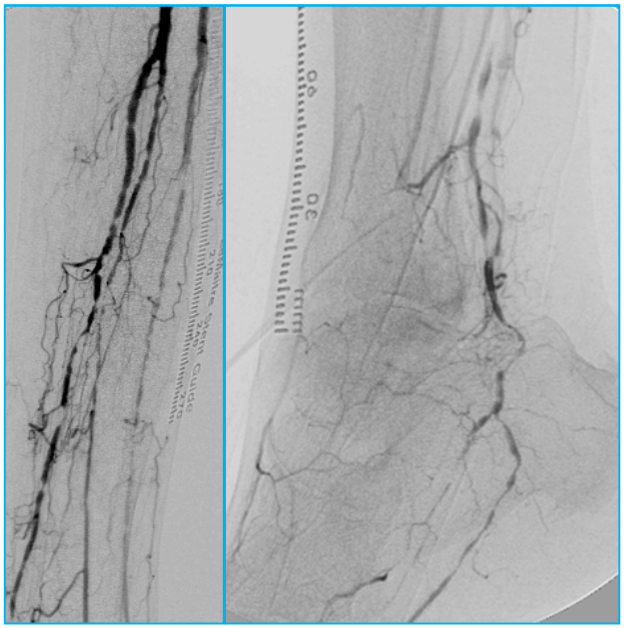
- Clinical evaluation
  - Fontaine stage III / IV
  - Neuro-ischemic ulcers
    - . TWC
    - . angiosome

- Arterial disease evaluation



To plan treatment at BTK level – PAOD evaluation

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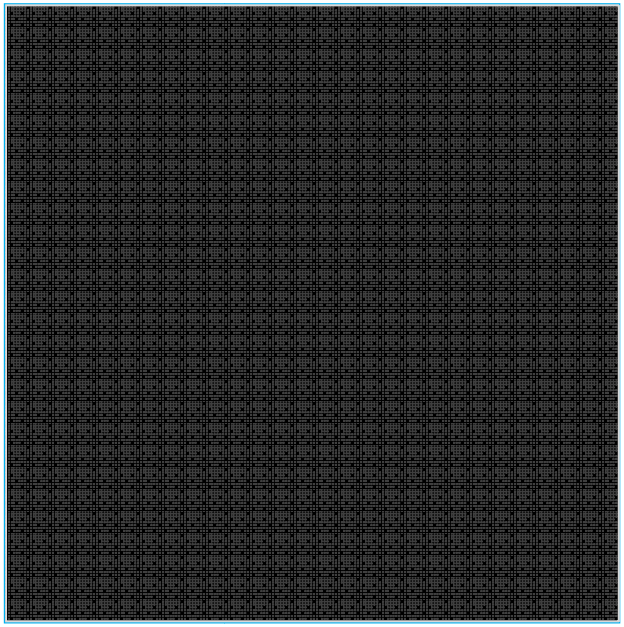

BTK revascularization – Fontaine Stage III

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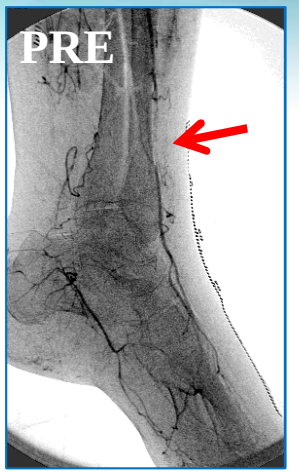
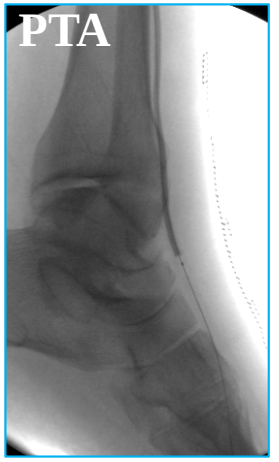
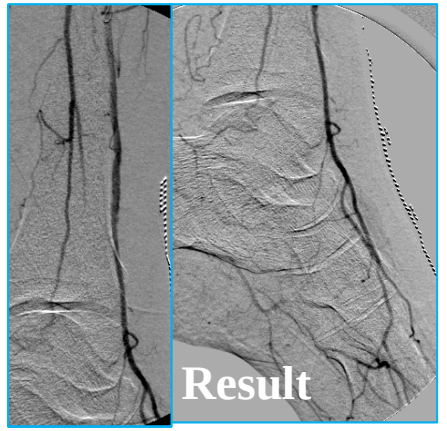
Primary end-point

Re-establishment of
pulsatile, straight-line **flow to the foot**

- Remove ischemic pain
- Prevent limb loss
- Improve quality of life
- Prolong survival







BTK revascularization – Fontaine Stage IV

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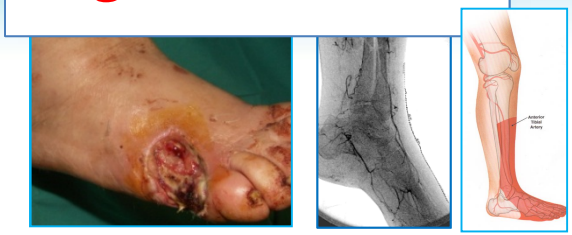
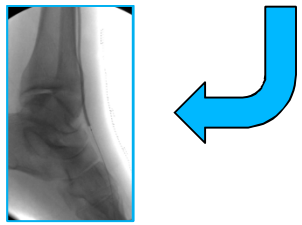
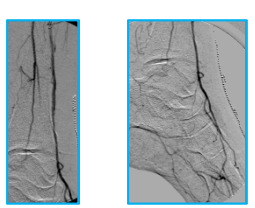
Ischemic Foot – revascularization according the Angiosome-Model



Primary end point

Re-establishment of
pulsatile, straight-line **flow to the angiosome**





- Healing of (neuro)ischemic ulcers
- Regression of ischemic pain
- Limb salvage
- Improve quality of life
- Prolong survival

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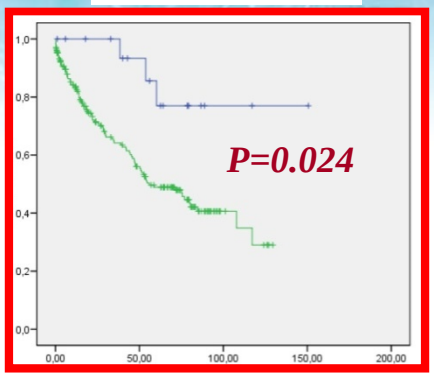
Survival

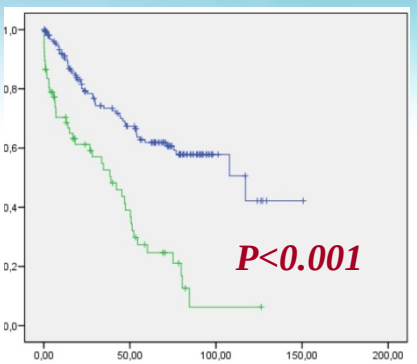
Fontaine stage



III

IV

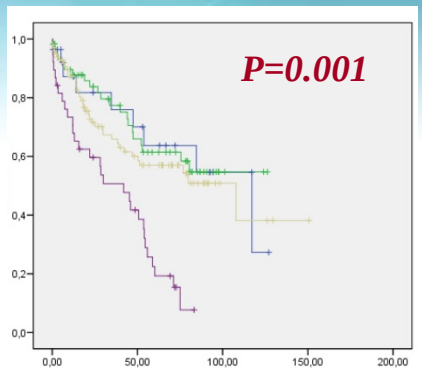
ESRD



NO

YES

AGE



< 60 years

61-70 years

71-80 years

> 80 years

Variables	Univariate	Multivariate	HR (95% CI)
Fontaine: IV **vs** III	0.017	0.024	2.63 (0.83-8.36)
ESRD: Yes vs No	< 0.001	<0.001	3.41 (2.28-5.1)
Age (years)	0.001	0.001	10.42 (10.18-10.67)
> 80 **vs**			
- ≤ 60			
- 61-70			
- 71-80			

To plan treatment at BTK level – PAOD evaluation

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    - . angiosome

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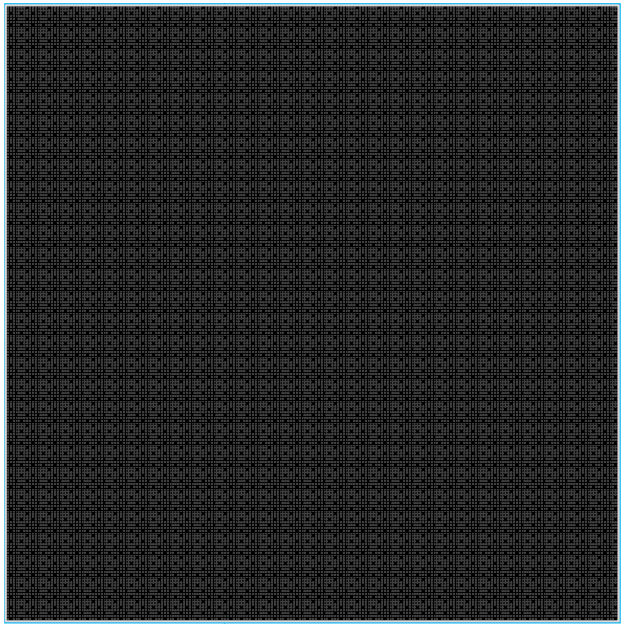

Validation of a diabetic wound classification system

Armstrong DG et al Diabetes Care 1998;21:855-859

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Stage \ Grade	0	I	II	III
A	Pre or post-ulcerative lesion 0%	Non-infected, non-ischemic, superficial ulceration 0%	Non-infected, non-ischemic, ulcer that penetrates to capsule or bone 0%	Non-infected, non-ischemic, ulcer that penetrates to bone or deep 0%
B	With infection 12.5%	With infection 8.5%	With infection 28.6%	With infection 92%
C	Without infection, With ischemia 25%	Without infection, With ischemia 20%	Without infection, With ischemia 25%	Without infection, With ischemia **100%**
D	With infection, With ischemia 50%	With infection, With ischemia 50%	With infection, With ischemia **100%**	With infection, With ischemia **100%**

The amputation risk is presented as %

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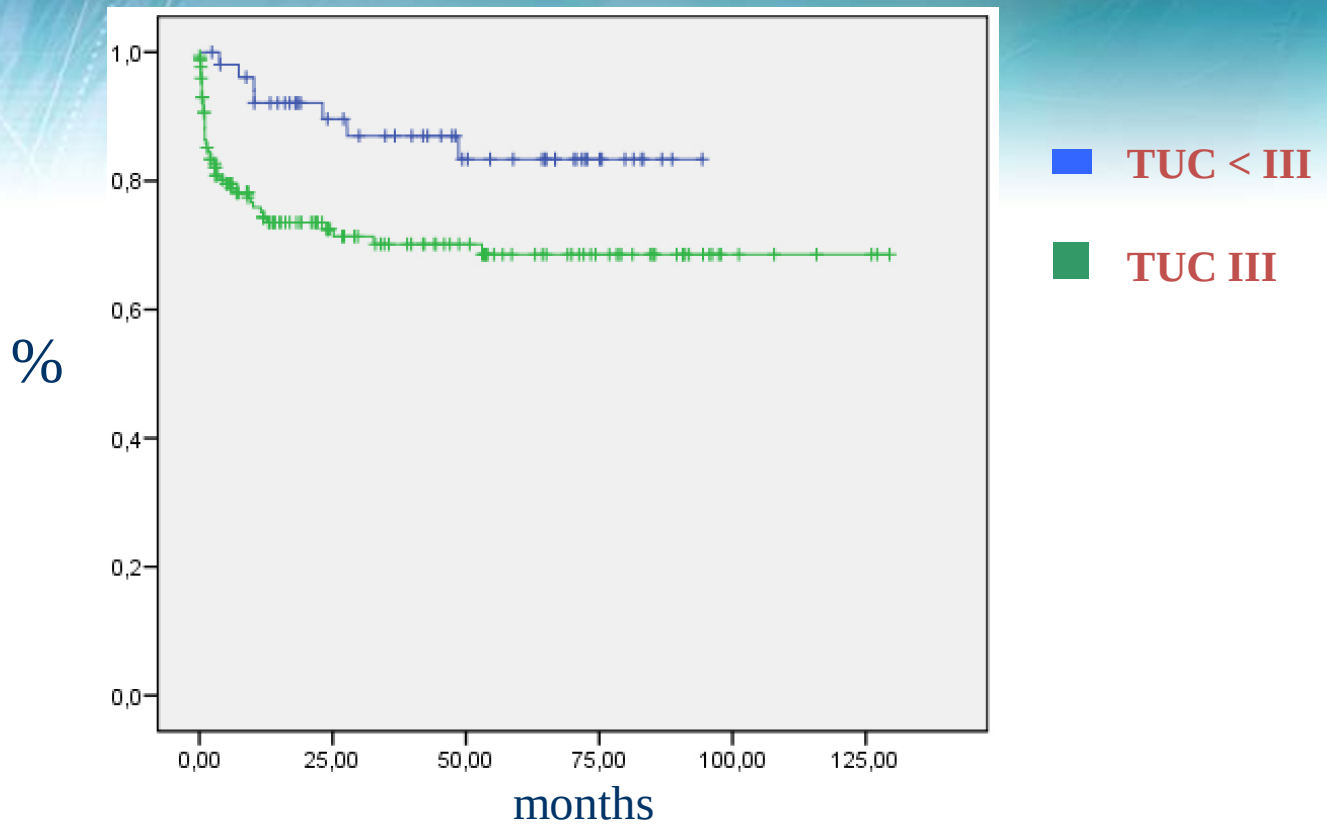
Limb Salvage



Variables	Univariate	Multivariate	HR (95% CI)
TUC: III **vs** <III	0.018	0.050	3.82 (1.72-8.47)
ESRD: Yes **vs** No	0.023	-	-

To plan treatment at BTK level – PAOD evaluation

- Clinical evaluation
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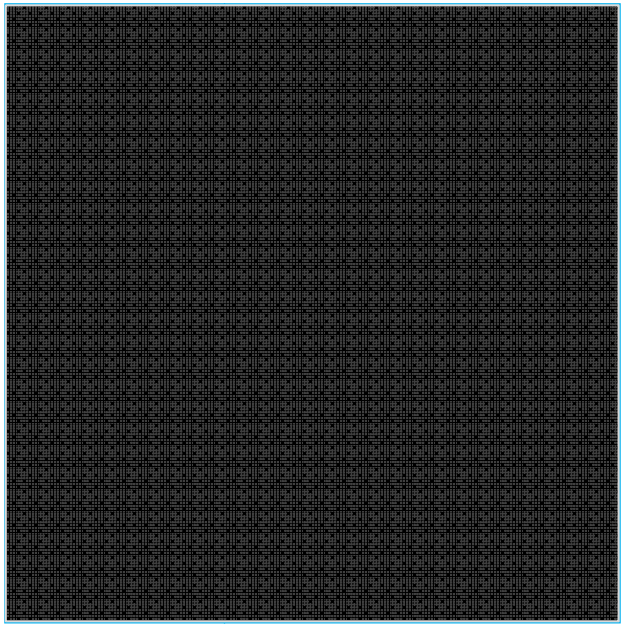
    - . angiosome

- Arterial disease evaluation



Angiosome of the leg: Anatomic study and clinical implications

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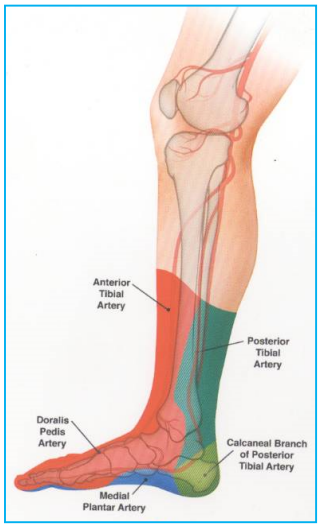
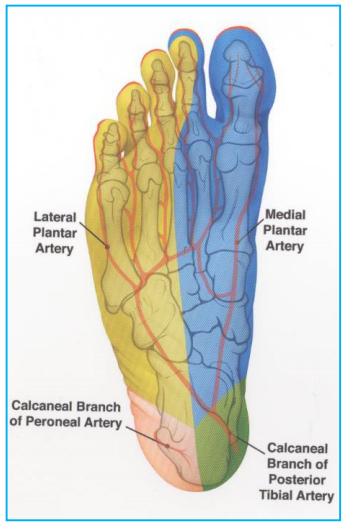
Taylor GI, Pan WR.
Plast Reconstr Surg 1998;102-599.

Ankle/Foot: 6 angiosomes

Posterior Tibial Artery (# 3)

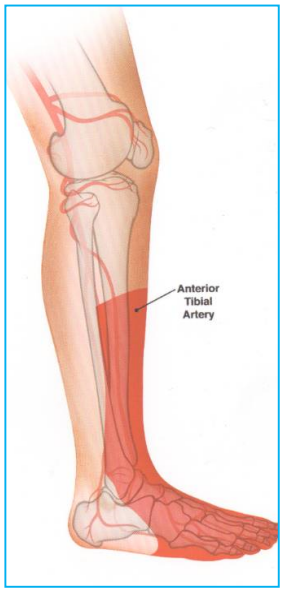
. Calcanear artery
. Medial plantar artery
. Lateral plantar artery

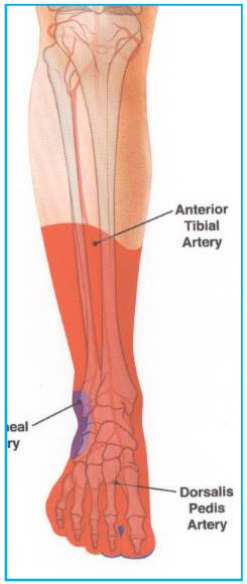




Anterior Tibial Artery (#1)

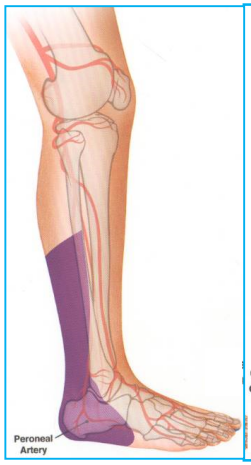
. Dorsalis pedis artery

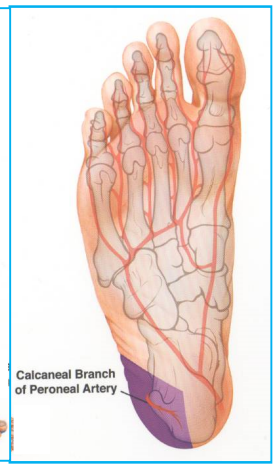




Peroneal Artery (#2)

. Calcanear artery
. Anterior perforating artery





Systematic Review and Meta-analysis of Direct versus Indirect Angiosomal Revascularisation of infrapopliteal arteries

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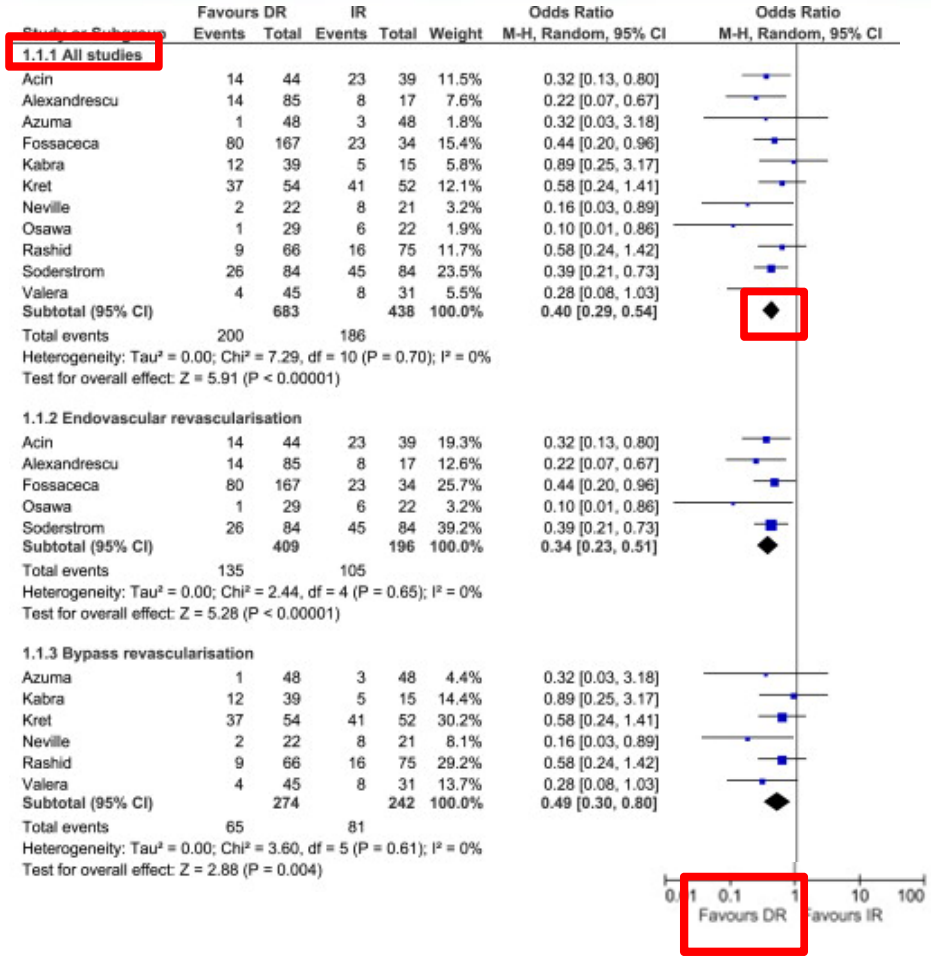
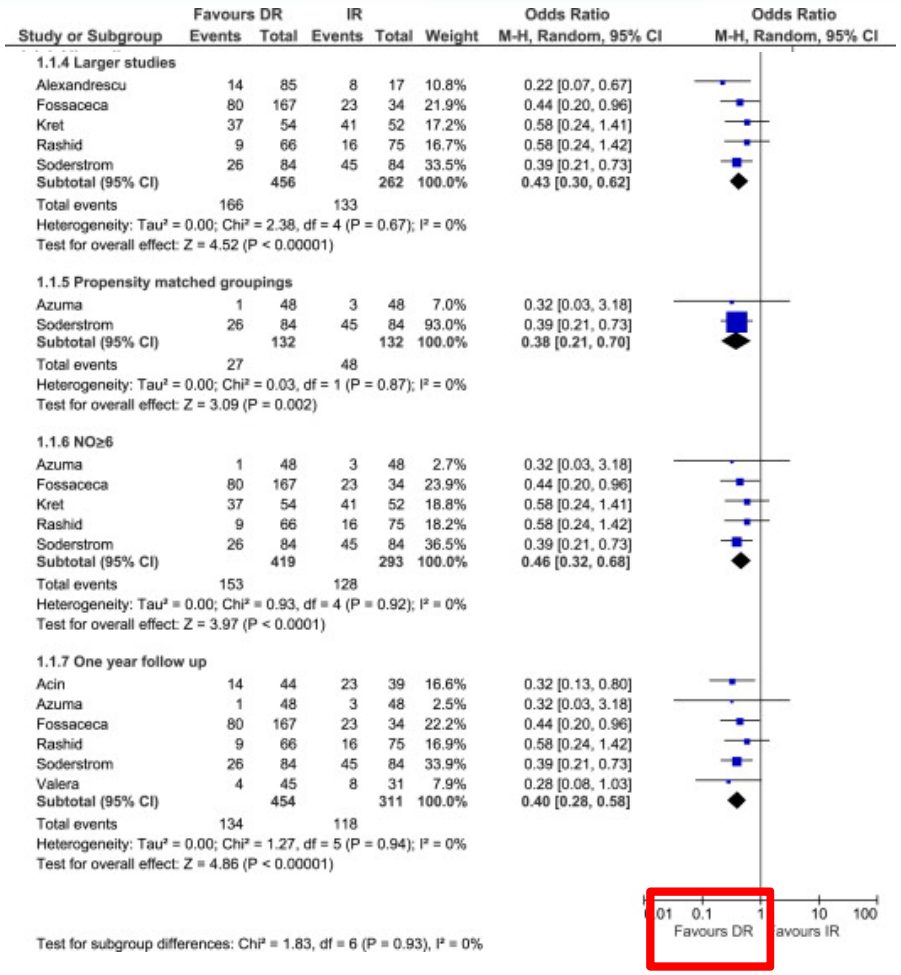
Bosanquet DC et al.
Eur J Vasc Endovasc Surg 2014; 48: 88-97

Wound healing





Worse Limb Prognosis for Indirect versus Direct Endovascular Revascularization only in Patients with Critical Limb Ischemia Complicated with Wound Infection and Diabetes Mellitus

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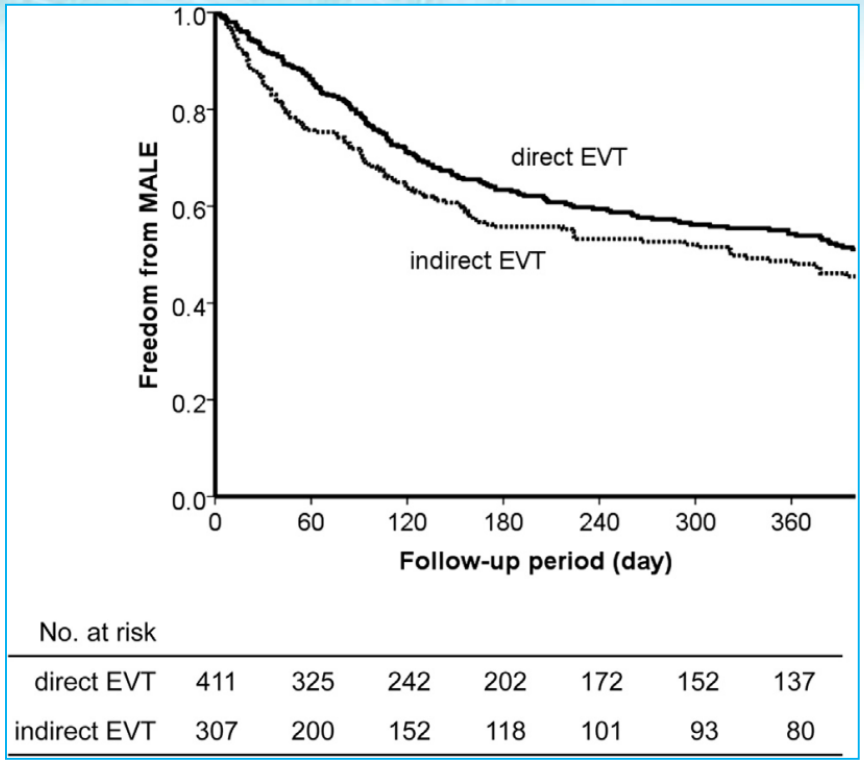
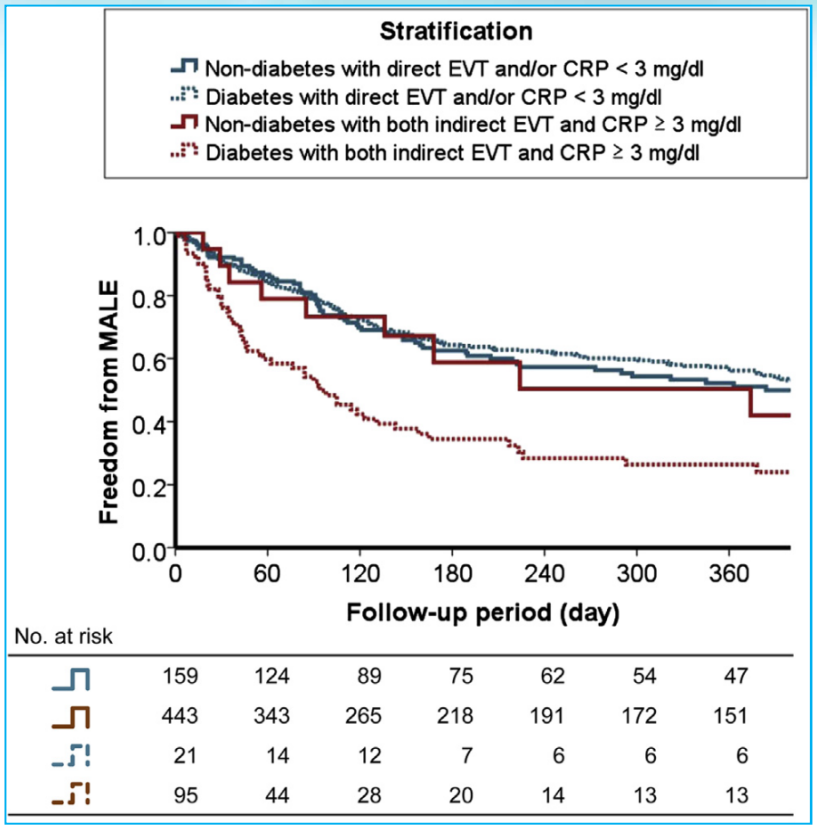
Iida O et al.
Eur J Vasc Endovasc Surg 2013, 46(5): 575-82



No. at risk							
direct EVT	411	325	242	202	172	152	137
indirect EVT	307	200	152	118	101	93	80

MALE: major amputation or any reintervention



No. at risk							
	159	124	89	75	62	54	47
	443	343	265	218	191	172	151
	21	14	12	7	6	6	6
	95	44	28	20	14	13	13

Conclusion: indirect EVT in patients with Diabetes and Wound Infection had a significant association with MALE

To plan treatment at BTK level – PAOD evaluation

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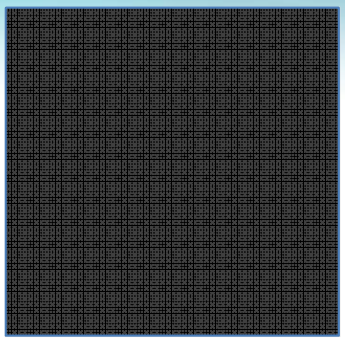
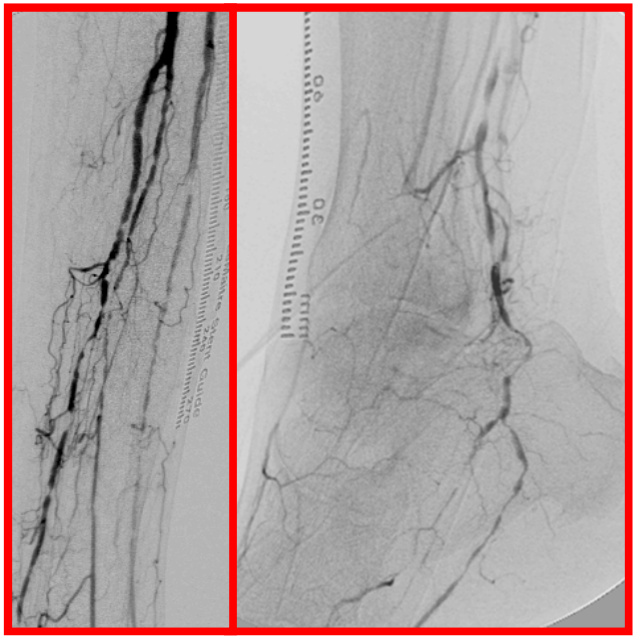
  - Neuro-ischemic ulcers
    - . TWC
    - . angiosome



- Arterial disease evaluation



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Imaging - End-points

- To define the presence of pathology
- To define the extension of pathology
- Run in, Run off (morphology and haemodynamic aspects)

Imaging of femoro-popliteal-tibial axis
Imaging of foot arteries

To plan treatment at BTK level – Arterial disease evaluation

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Imaging

- Doppler CW, ABI
- Duplex
- TcPO2
- Angio MRI, Angio CT
- Angiography

To plan treatment at BTK level – Arterial disease evaluation

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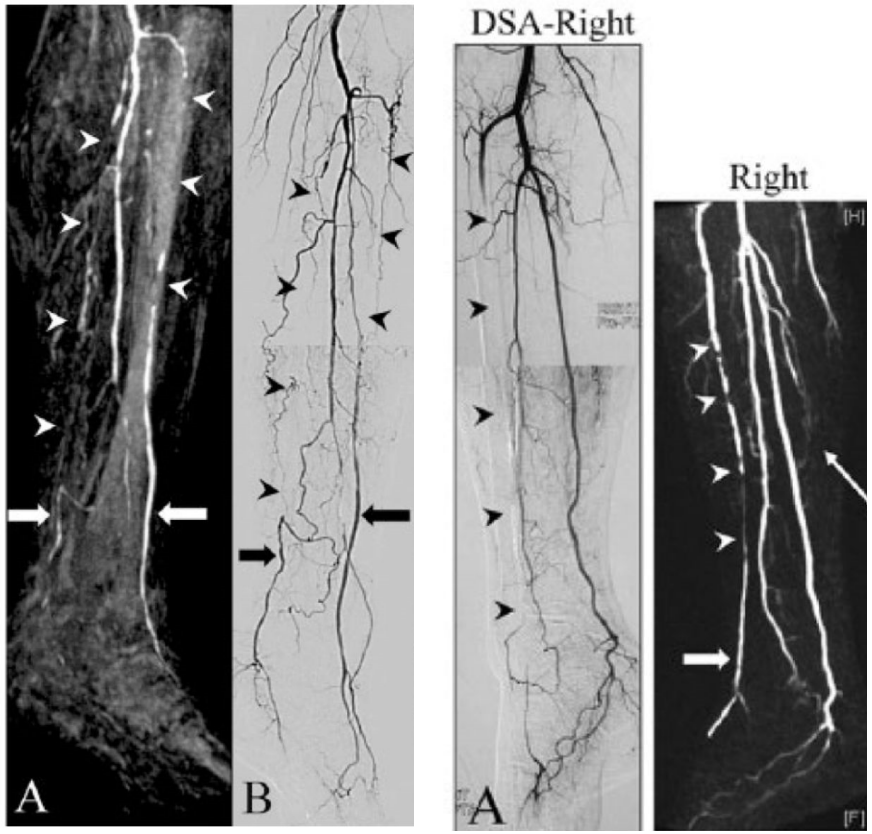
Imaging

- Doppler CW, ABI
- Duplex
- TcPO2
- **Angio MRI**, Angio CT
- Angiography

To plan treatment at BTK level – Arterial disease evaluation

Imaging – MR Angiography

- *Lapeyre M et al Am J Roentgenol 2005; 185: 1641-1650*
- *Diehm N et al Invest Radiol 2007; 42: 467-476*



- DSA may fail to correctly depict tibial artery especially distal to long-segment occlusions.

- Late contrast enhancement of distal runoff vessels with retrograde filling via collaterals may also not be visible on DSA images.

YQ Zhu et al.
J Endovasc Ther 2015;22:243-251
N. Diehm
J Endovasc Ther 2015: 22; 252-253

To plan treatment at BTK level – Arterial disease evaluation

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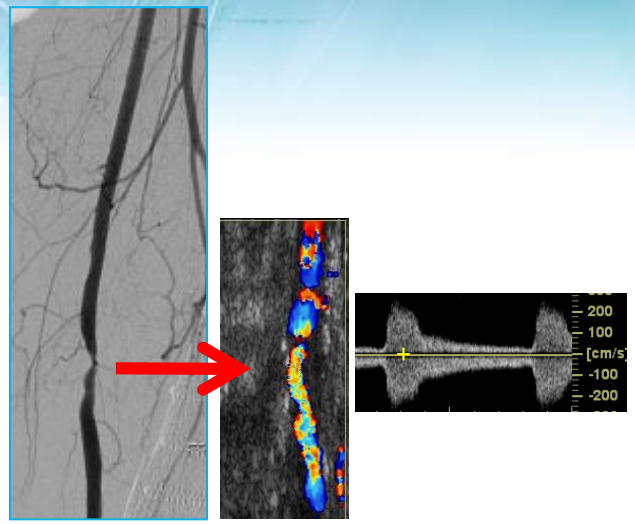
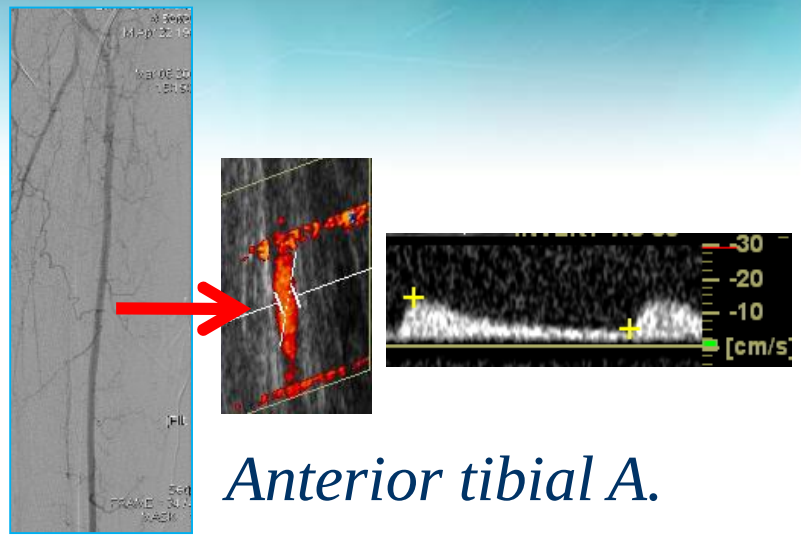
Imaging

- Doppler CW, ABI
- **Duplex**
- TcPO2
- Angio MRI, Angio CT
- Angiography

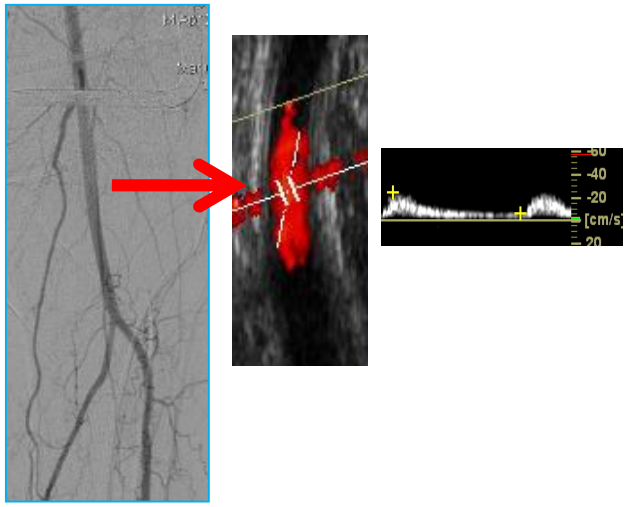
Tibial arteries disease: Ultrasound evaluation



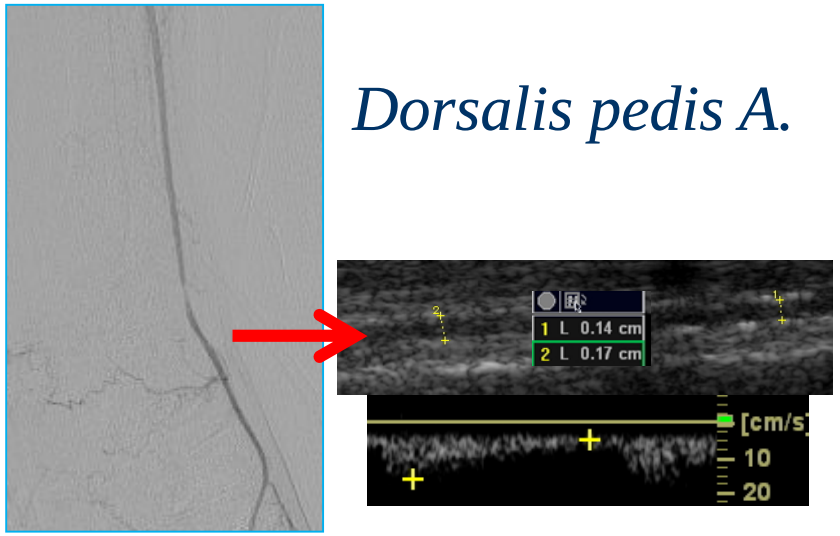
SFA



Anterior tibial A.



Popliteal A.



Dorsalis pedis A.

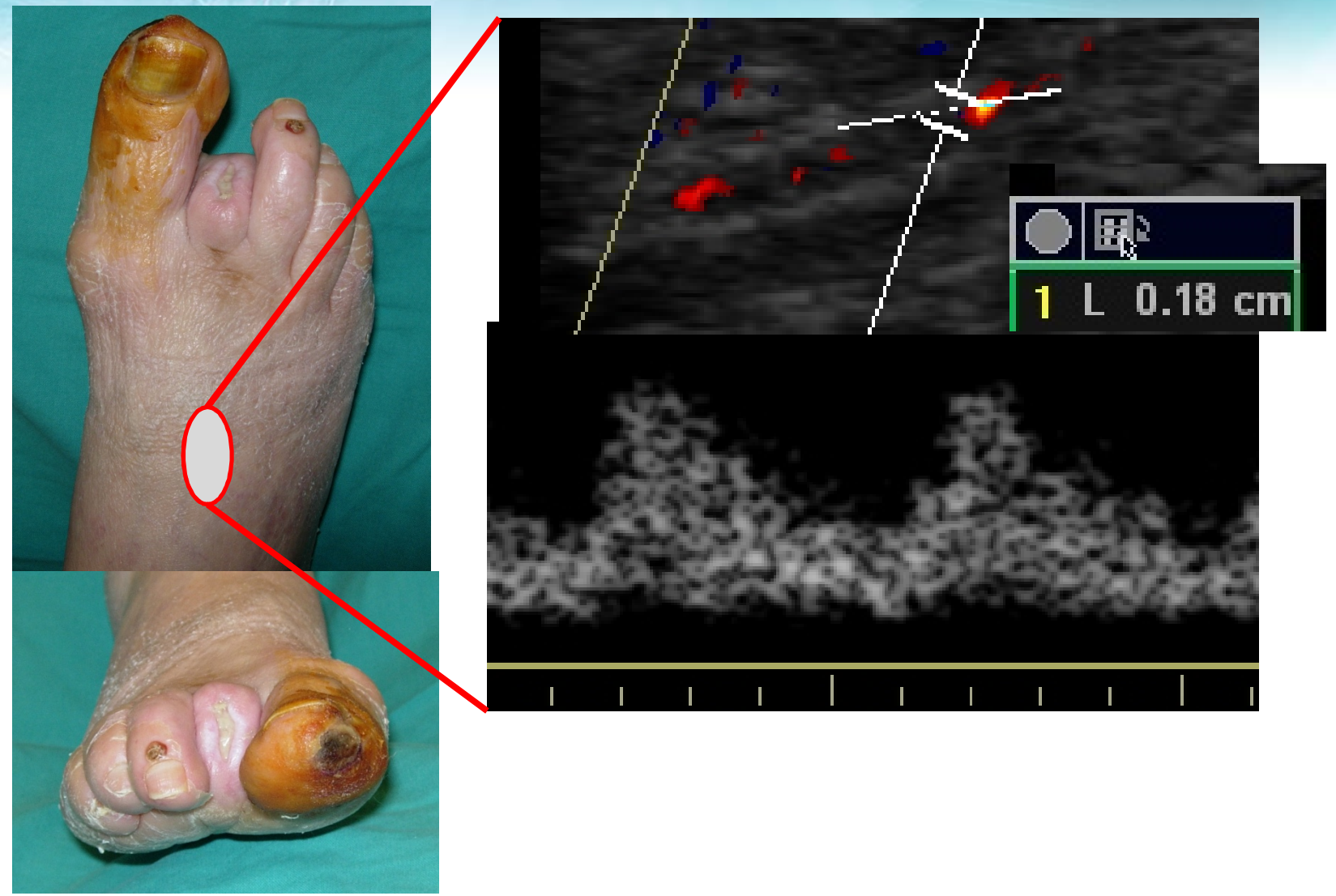
DUS assessment of tibial arteries in patients with arterial disease: a Systematic Review

Artery	Sensitivity (%)	Specificity (%)
TPT	25-71	87-100
ATA	72-98	35-100
Peroneal a.	89-94	21-58
PTA	79-100	40-100
Dorsalis pedis	33-85	76-89
Plantar arteries	43-78	76-100

Bianchini Massoni C. 2014

Neuroischemic foot – TUC III C

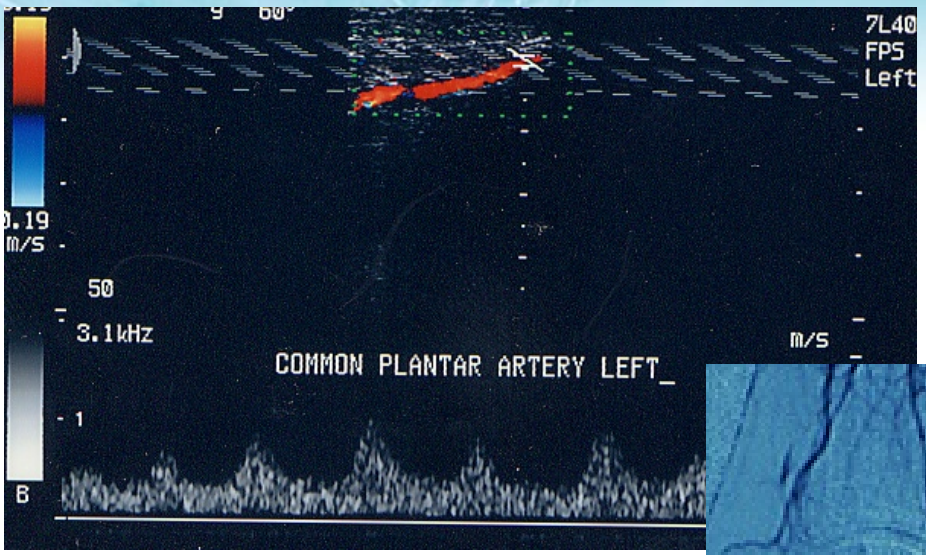
Angio: Posterior tibial artery, Peroneal artery and Anterior tibial artery long occlusion, no foot arteries

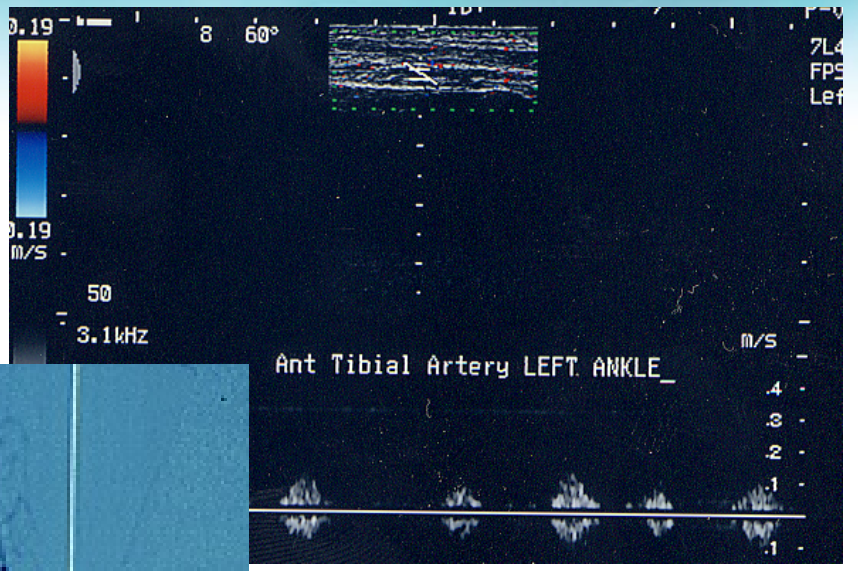


Tibial arteries disease in diabetic patients:

Can colour duplex mapping of the ankle and foot arteries improve the vascular program?

M Gargiulo, A Stella, S Tarantini et al ESVS 2000





GOOD
RUN OFF

POOR
RUN OFF

Neuro-ischemic foot

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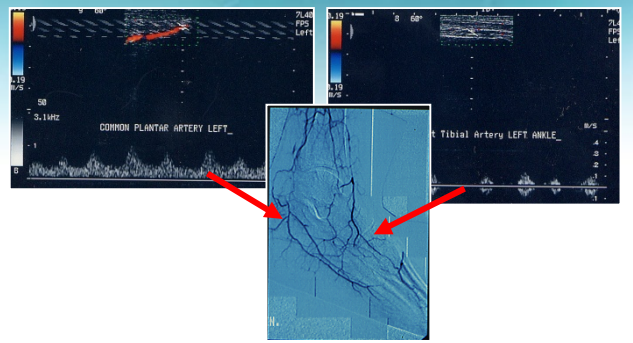
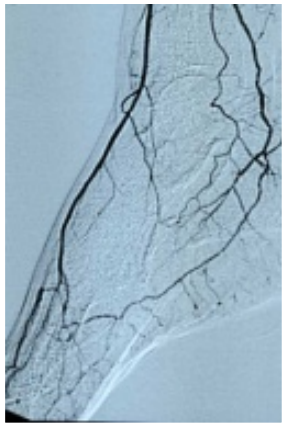
Duplex ultrasound arterial mapping
from the EIA to the pedal arteries

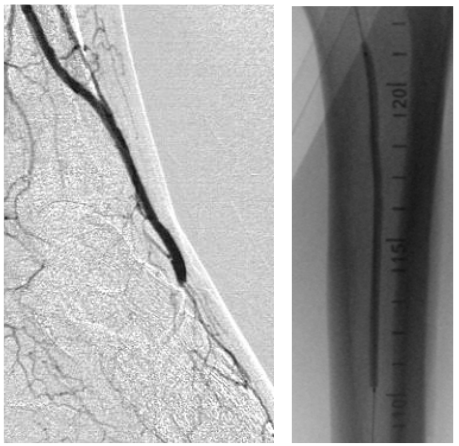


Arterial wall calcification
Extensive ulcers
Edema
Very poor run in or run off

Arteriography



Lower Extremity
Revascularization



Angiosomes: How Do They Affect My Treatment?

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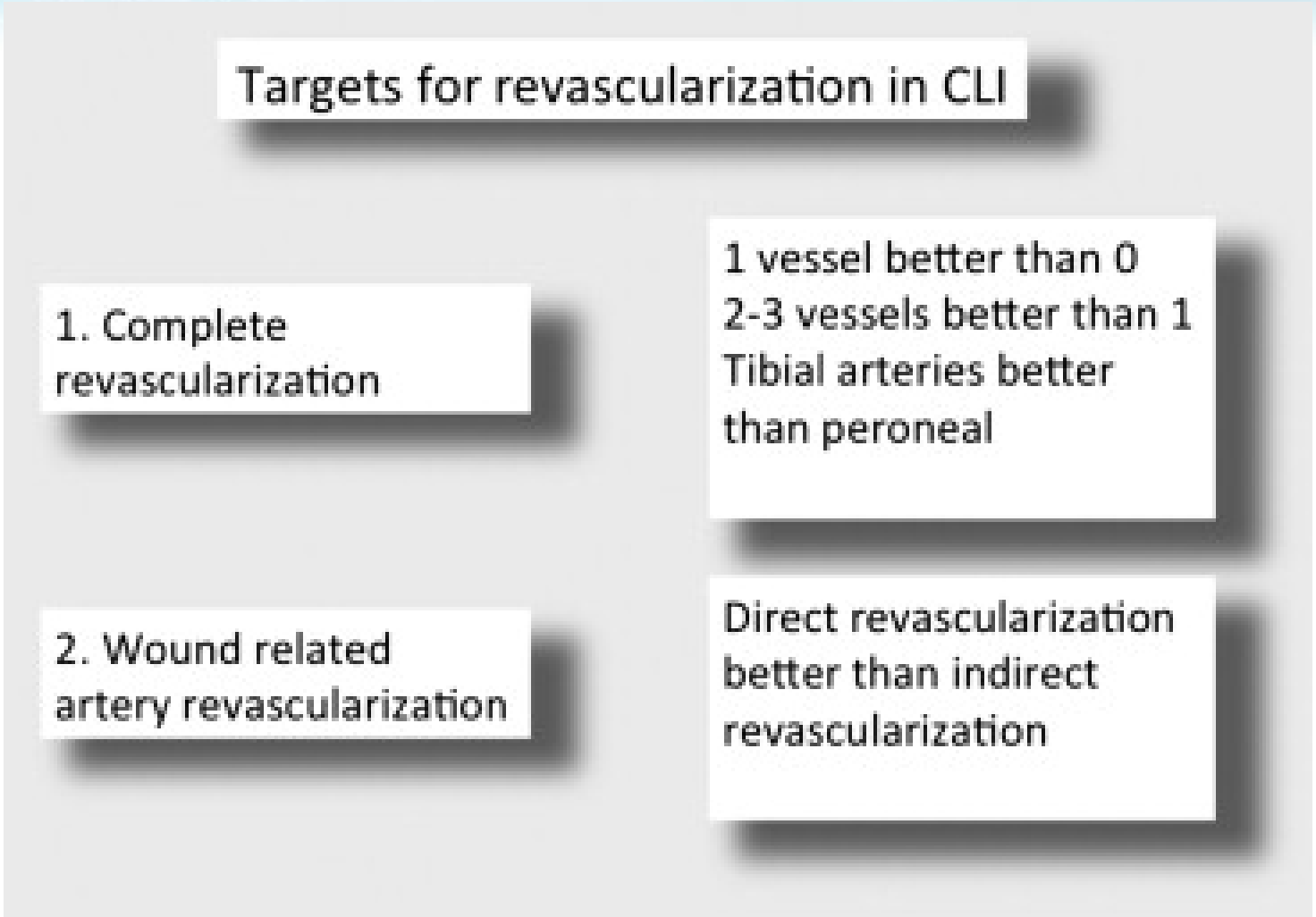
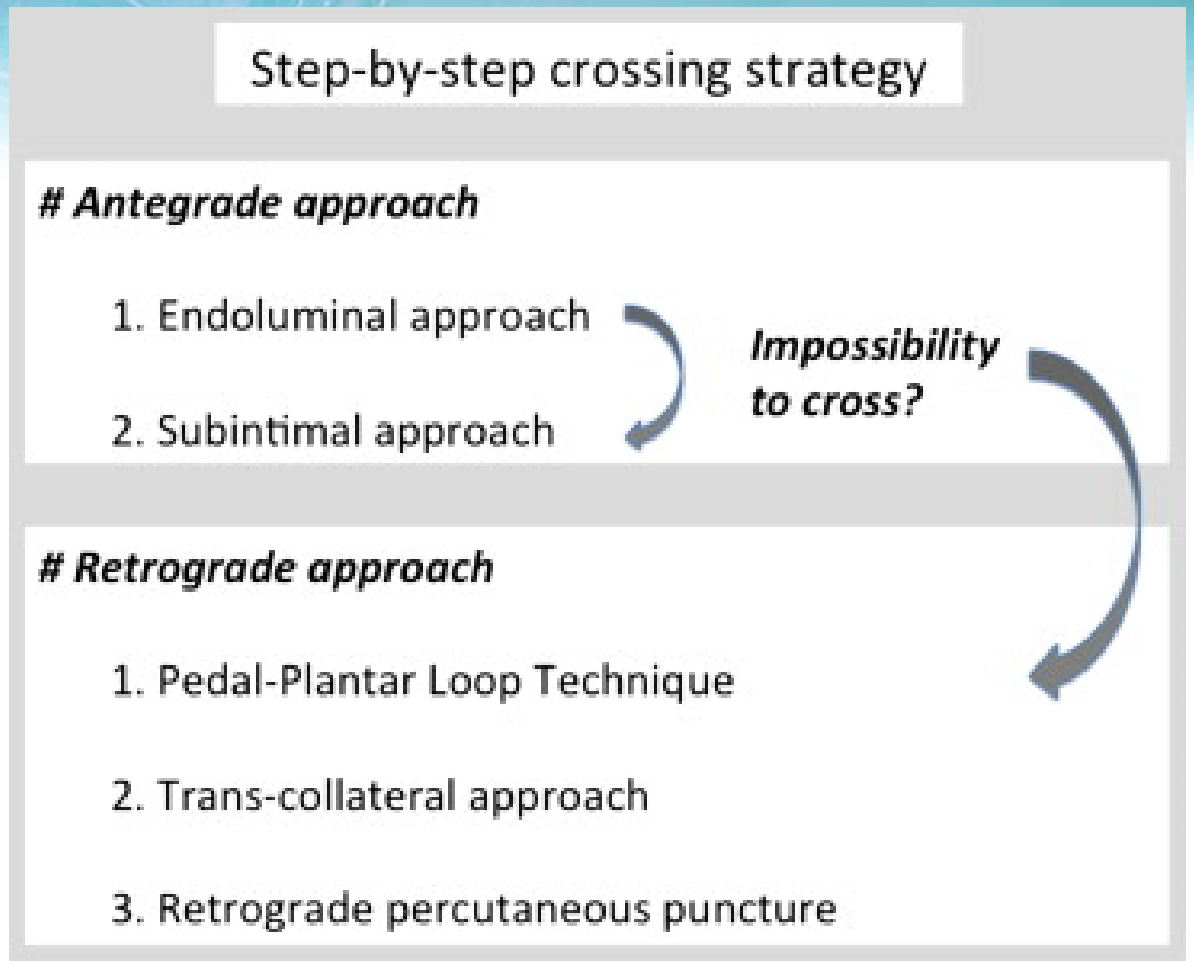
LM Palena et al.
Tech Vasc Intervent Radiol 2014; 17:155 - 169



Treatment at BTK level



R. Ferraresi et al
J Cardiovasc Surg 2013; 54: 685-711
LM Palena et al.
Tech Vasc Intervent Radiol 2014; 17:155 - 169

Case # 1 - Tibial arteries stenosis - PTA

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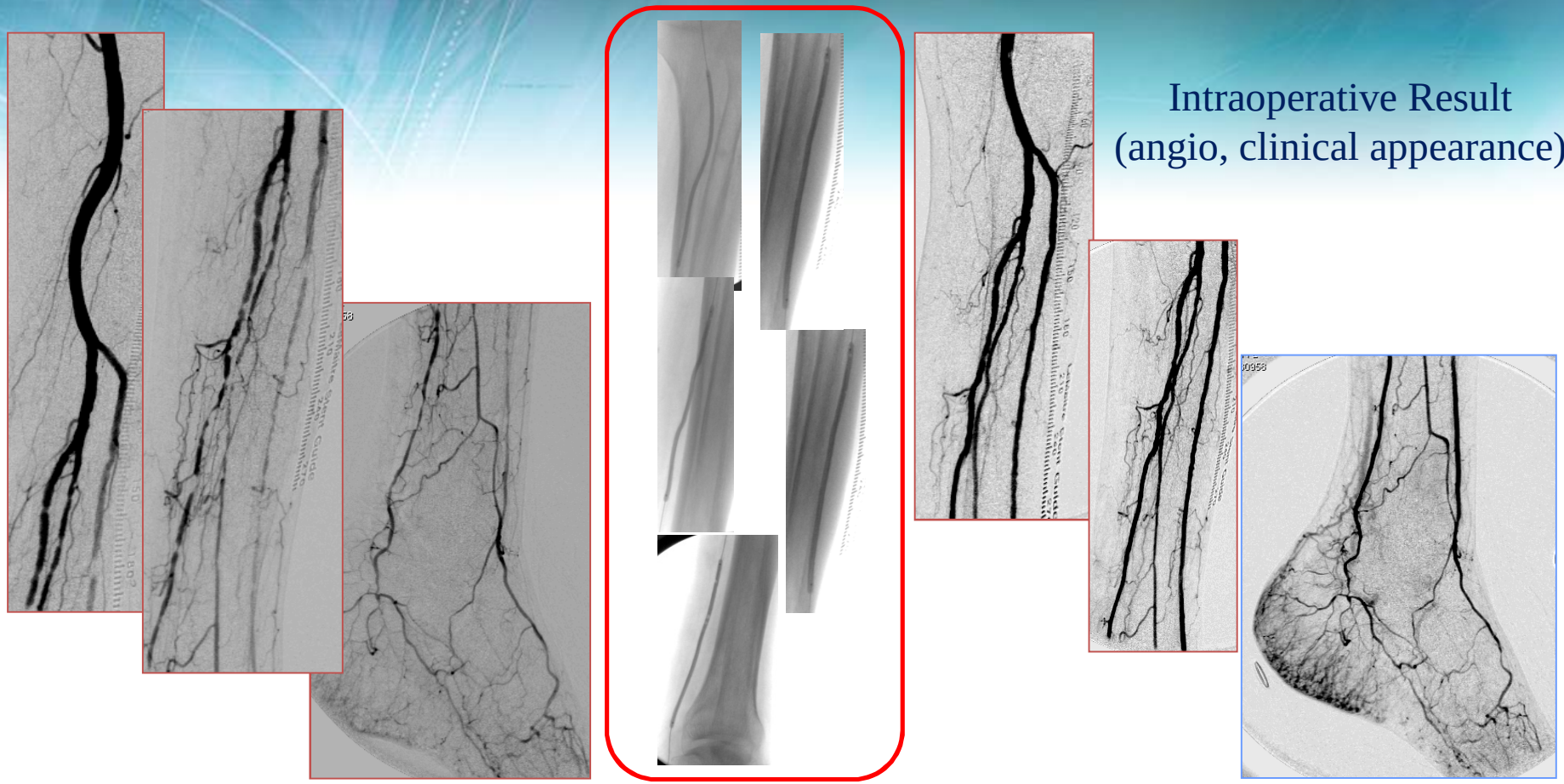
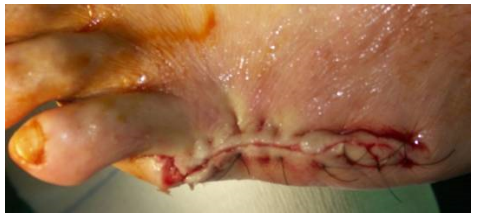
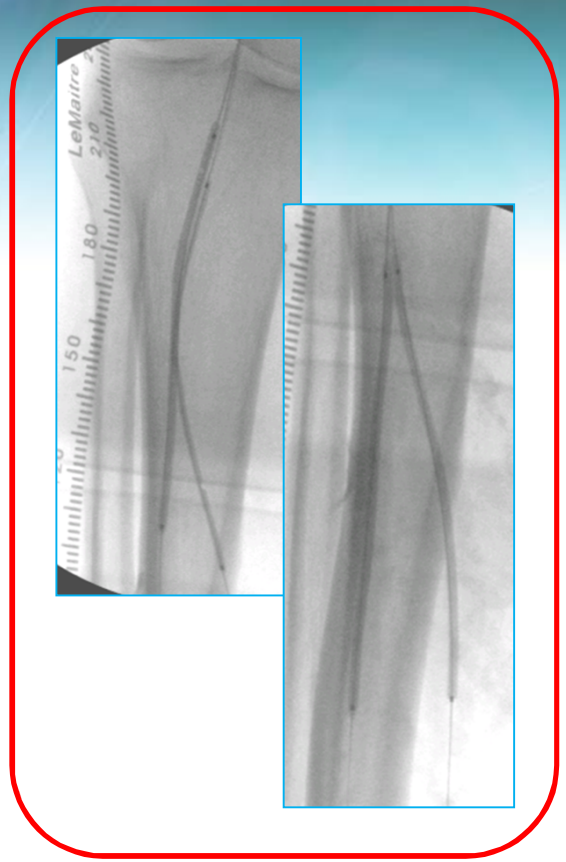


Intraoperative Result
(angio, clinical appearance)

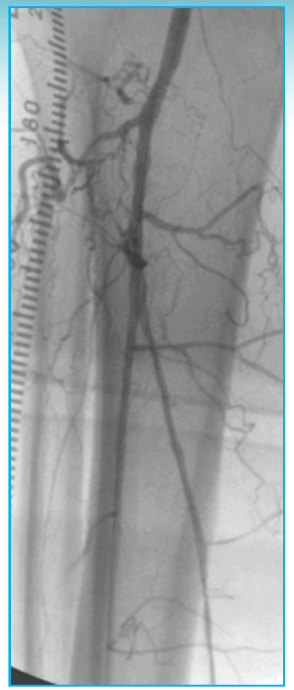


Follow up 1 month

Case # 2 – Tibial-peroneal trunk obstruction - PTA



Intraoperative Result



TUC III D

Kissing balloon technique

Gargiulo M et al

Eur J Vasc Endovasc Surg 2008; 36:197-202

Follow up 10 months

CLI and tibial arteries disease – Endovascular treatment Results

Authors	Limbs	Technical success
Schwarten 1988	114	97%
Saab 1992	14	100%
Matsi 1993	84	83%
Durham 1994	14	100%
Hauser 1996	47	80%
Lofberg 1996	86	88%

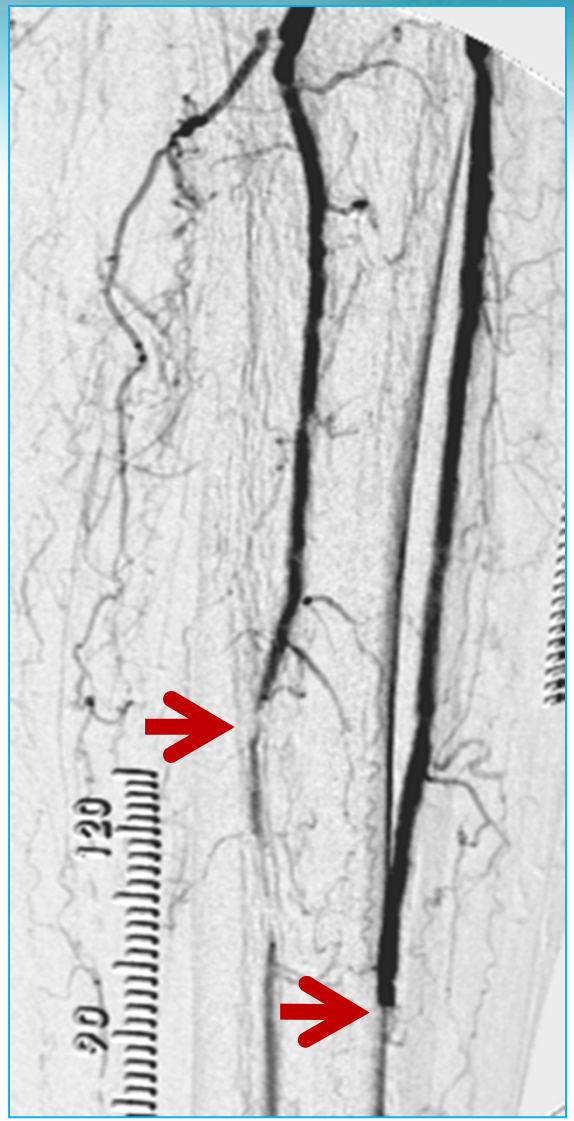
Technical Failure 0-20%

CLI and tibial arteries disease – Endovascular treatment Results

Authors	Limbs	Technical Success
Faglia E. et al *Eur J Vasc Endovasc Surg 2005*	1188	83.6%
Romiti M et al. *J Vasc Surg 2008*	2693	89%
Ferraresi R. et al *Eur J Vasc Endovasc Surg 2009*	107	93.5%
Alexandrescu V et al *J Endovasc Ther 2011*	232	**80%**
Our Experience 2012 *Not published data*	249	**97.2%**

Technical Failure 3-20%

Arterial calcification and PAOD



Arterial calcification and PAOD

MEET 2015 MULTIDISCIPLINARY EUROPEAN ENDOVASCULAR THERAPY

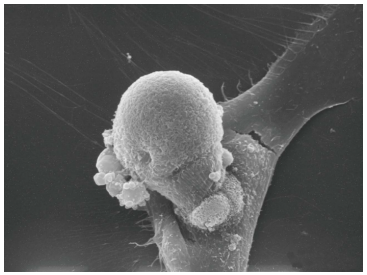
Peripheral arterial calcification: prevalence, mechanism, detection and clinical implications

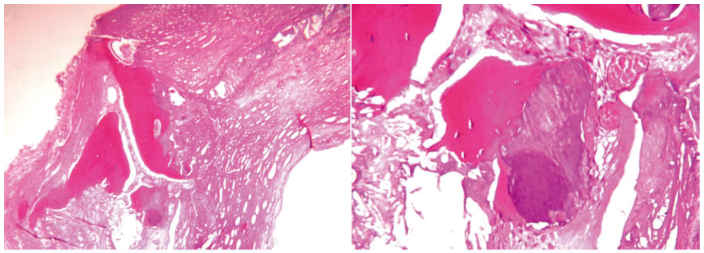
Rocha-Singh K et al.
Catheterization and Cardiovasc interventions 2014; 83: E212-E220

Vascular Calcification

- Passive process: the results of Calcium and Phosphate ions exceeding solubility in tissue fluid, inducing the precipitation and deposition of hydroxyapatite crystals

- Attive process: VC is a result of intracellular molecular process involving the differentation of macrophages and VSMCs into osteoclast-like cells





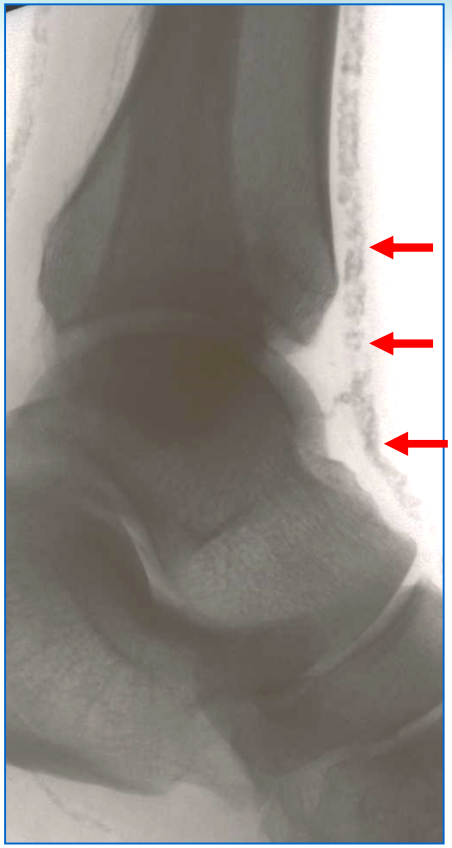
Diabetic PAOD

1. Macroangiopathy is most often seen in popliteal and tibial arteries

2. The lesions tend to be more extensive

3. **Histopathological lesions**
   - **Macroangiopathy**
     - atherosclerosis
     - diffuse intimal fibrosis
     - **medial calcific sclerosis**
   - Microangiopathy
     - no small artery or arteriolar occlusive lesion

4. Patency of the ankle and foot arteries



LoGerfo FW
J Vasc Surg 1987; 5: 793-6

Anatomical Predictors of Major Adverse Limb Events after Infrapopliteal Angioplasty for Patients with Critical Limb Ischaemia due to Pure Isolated Infrapopliteal Lesions

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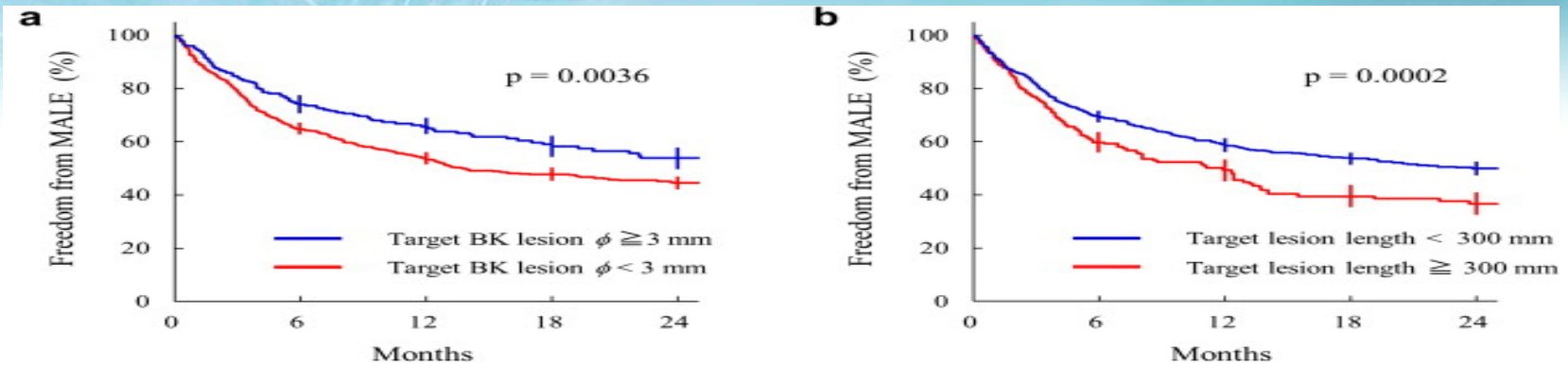
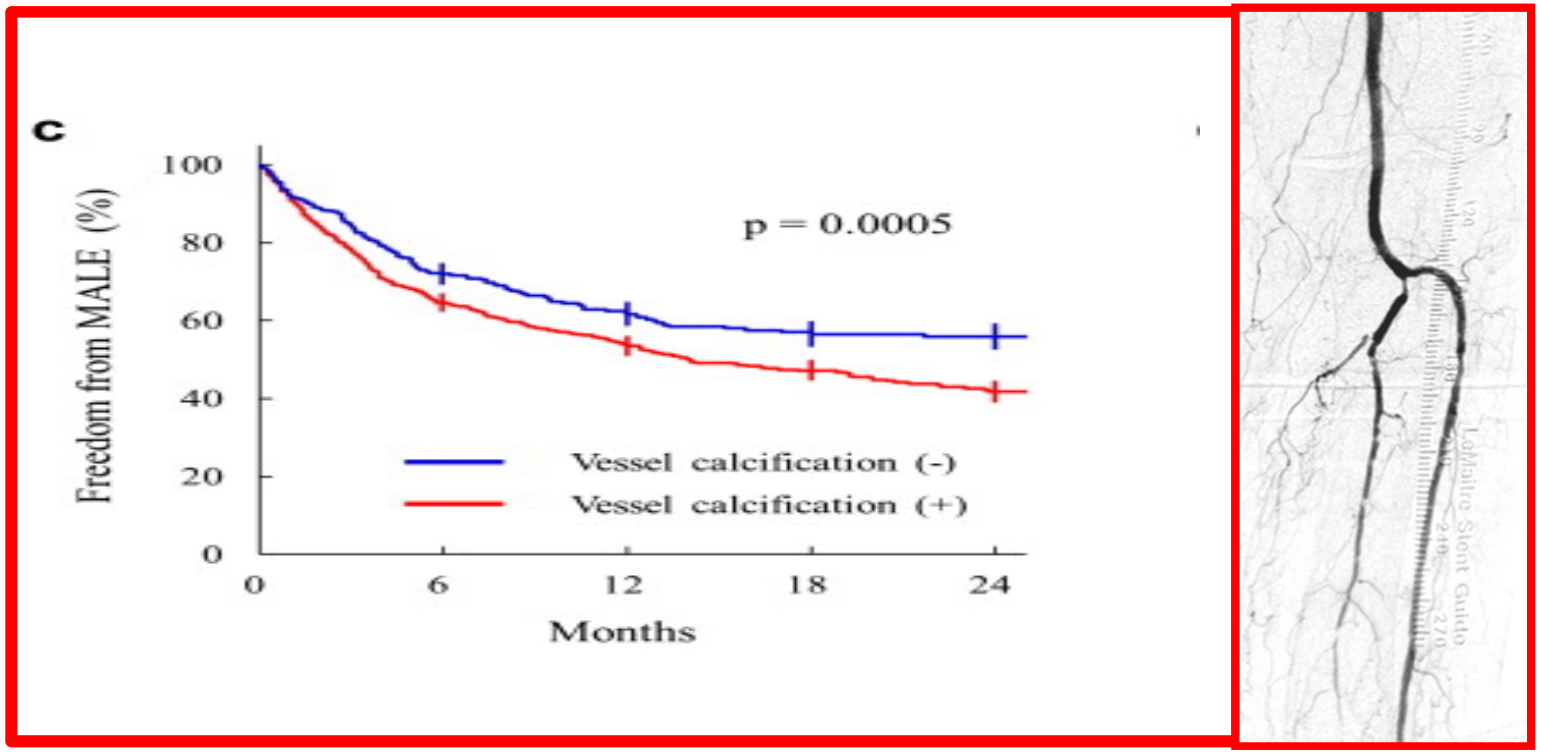
Iida O et al.
EJVES 2012; 44: 318 - 324

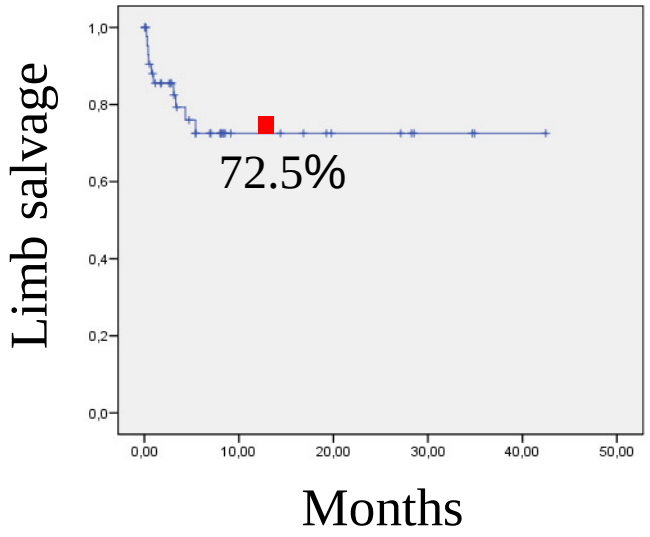


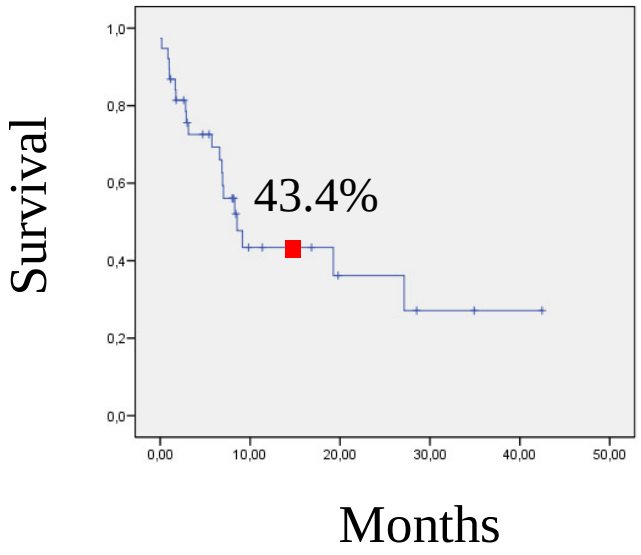


Endovascular treatment of the tibial arteries in heamodialysis patients with critical limb ischemia: is it justified?

C. Bianchini Massoni et al
Ann Vasc Surg 2014

Pts	39
Limbs	46
Infrapopliteal target arteries	91
Technical Success	**89%**





Arterial calcification and PAOD

MEET 2015 MULTIDISCIPLINARY EUROPEAN ENDOVASCULAR THERAPY

Peripheral arterial calcification: prevalence, mechanism, detection and clinical implications

Rocha-Singh K et al.
Catheterization and Cardiovasc interventions 2014; 83: E212-E220

Proposed Peripheral Arterial Calcium Scoring System (PACSS)

Grade 0: No visible calcium at the target lesion site

Grade 1: unilateral calcification < 5cm; a) intimal calcification; b) medical calcification; c) mixed type

Grade 2: unilateral calcification ≥ 5cm; a) intimal calcification; b) medical calcification; c) mixed type

Grade 3: bilateral calcification < 5cm; a) intimal calcification; b) medical calcification; c) mixed type

Grade 4: bilateral calcification ≥ 5cm; a) intimal calcification; b) medical calcification; c) mixed type

This scoring system is based only on the length of the calcified portion but do not take in consideration the circunferential distribution

Association of lower extremity arterial calcification with amputation and mortality in patients with symptomatic peripheral artery disease.

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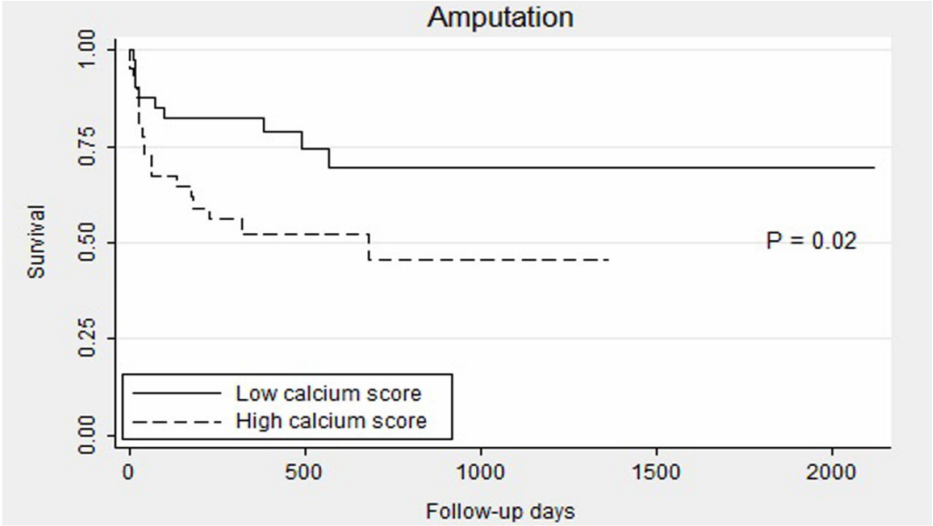
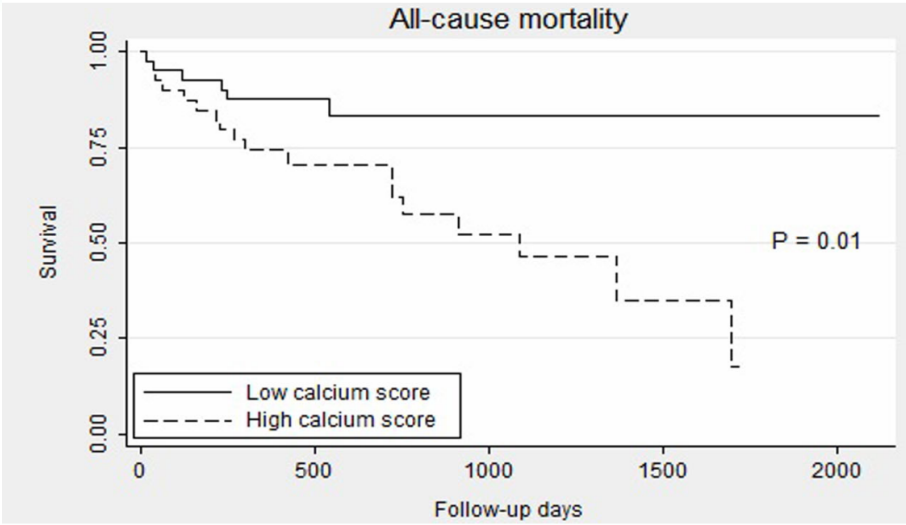
Huang CL et al.
Plos 2014; 9: 1-6





Arterial status, angiosome, arterial calcifications: it is possible to plan treatment at BTK level ?

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Conclusion

Arterial status, angiosome, arterial calcifications: it is possible to plan treatment at BTK level ?

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Conclusion

YES

Arterial status, angiosome, arterial calcifications: it is possible to plan treatment at BTK level ?

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Conclusion

YES

- Clinical evaluation
  - Fontaine stage III / IV
  - Neuro-ischemic ulcers
    - . TWC
    - . angiosome
- Arterial disease evaluation
  - Extension
  - Run in, run off
  - Tibial and foot arteries calcium score

To plan treatment at BTK level – Arterial disease evaluation

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Imaging

- Doppler CW, ABI
- Duplex
- TcPO2
- Angio MRI, Angio CT
- Angiography
- **Tibial and foot arteries X-Ray**