

Surgical arterialisation of the plantar venous system for foot salvage after failed endovascular or operative revascularisation



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Disclosure

Speaker name: Achim Neufang

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I have the following potential conflicts of interest to report:

- Consulting
- Employment in industry
- Stockholder of a healthcare company
- Owner of a healthcare company
- Other(s)

- I do not have any potential conflict of interest

Historical Background

SURGERY, GYNECOLOGY AND OBSTETRICS

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ARTERIOVENOUS ANASTOMOSIS IN THE TREATMENT OF GANGRENE OF THE EXTREMITIES

By ALBERT E. HALSTEAD, M. D., AND ROGER T. VAUGHAN, M. D., CHICAGO, ILLINOIS

THE application in clinical surgery of the experimentally successful procedure of reversal of the circulation in the arteries and veins has been proposed as a means of treatment of conditions which have for their underlying cause a failure of the arteries to perform their function of conveying red blood to the tissues.

mosis cannot be fixed by experimental data alone. Its place in surgery can only be determined by actual clinical experience. For this reason we have collected all of the available cases published, and, in addition, have added a number of cases, including two of our own. From an analysis of these we hope to secure data that will permit us to place this

N=16

Mortality 9/16

TABLE OF CASES

Age	Sex	Operator	Publication	Pathology	Results, immediate	Remote results	Anatomy findings	Technique
34	M.	San Martin	Royal Acad. of Sci. Madrid, 1907	Gangrene of great toe and part of ankle	Satisfactory	Gangrene spread on sixth day. Amp. thigh. Death	Collateral endarteritis	End-to-end. Femoral vessels
36	M.	San Martin	Same references	Gangrene from light bank-rupt. Death of toe	Toe disappeared	Spontaneous. Wound healed. Recovery		End-to-end. Femoral vessels
37	M.	Jabouley	Rev. de Chir. Paris, 1887, 128	Amputation of right tibia for gangrene. Gangrene of left leg	No pulsation, nor other favorable signs. Change in blood	Gangrene progressed. Amp. thigh on fifth day. Death		Large vessels all thrombosed. Artery obliterated
38	M.	Halsband	Annals of Surg., Oct., 1909	Small gangrene of part of right foot	Slight pulsation in femoral vein, foot below anastomosis	Gangrene extended. Amputation one month after. Recovery	At time of operation both thighs contained red blood	End-to-end. In Scarpa's triangle.
7	F.	Dobsoner	St. de Med. All. St. Bohemi, 1907	Thrombotic gangrene. Extension of vessels. Arteriovenous tunic dense	Active pulsation in vein below, continued for days after	Not marked. Recovery	Some made	Evacuation of femoral artery into femoral vein
36	F.	Halsband	Brit. Med. and Surg. Jour., 1909	Thrombotic gangrene of foot due to arteriosclerosis	Venae filled; color good; no pulsation	Gangrene extended; amputation two weeks after. Recovery	Red blood aspirated from femoral vein at operation	Direct's end-to-end.
30	F.	Lilienthal	Annals of Surg., 1909, v. 37	Gangrene from obliterating arteritis. Obliteration of arteries	No signs of improvement	Shed. Death in 20 hours.		Operation. Physical artery, anastomosis, femoral small
40	M.	Torrence	Annals of Surg., 1909, v. 37	Traumatic; not related to last. Sept. vein	Pulsation in artery for one day; then ceased	Foot healed; artery healed; leg amputated four months later. Recovery	No examination of anastomosis	End-to-end by intravascular.
36	M.	Tuller	Bull. et Mem. de la Soc. de Chir., 1897	Syphilitic gangrene of three months' standing of foot	Venae dilated and pulsated; eight days, feet not improved	No operation. Death on eleventh day. Death		End-to-end by anastomosis.
30	M.	Tuller	B. Central. Chir. de Paris, 1897	Alcoholic beginning gangrene of foot	Pulsation in vein, along course of internal saphenous	Gangrene. Reversed anastomosis. Improvement. Recovery		End-to-end at middle of thigh.
33	F.	Balfanz	Lancet, London, 1904, i, 747	Scalae gangrene extending to dorsum of foot	Pulsation in saphenous and dorsalis pedis veins same day	No extension. Thrombotic gangrene returned to normal. Recovery	No report	Technique not mentioned
36	M.	v. Schindler	Ber. Hlg. Wech., 1905, No. 12	Proximal gangrene; previous amput. of opposite foot	Anastomosis could not be made	Amputation within line of Resceux	Artery found obliterated	No anastomosis.
61	M.	v. Schindler	Ber. Hlg. Wech., 1905, No. 12	Dry gangrene of toes on right foot	Anastomosis could not be made	No change. Gangrene remained stationary. Recovery	Artery obliterated; gangrene	No anastomosis.
45	F.	v. Schindler	Ber. Hlg. Wech., 1905, No. 11	Embolic gangrene from thrombosis. Right foot amputated. Left foot healed	Venae pulsated. None in veins of foot. Color improved	No change in symptoms. Death day following.	Endocarditis; thrombosis in post. tib. saphenous artery	Carrel's end-to-end.
63	F.	Mauchère	Arch. Gen. de Chir., 1910, v. 1, 813	Embolic gangrene of right foot. Line of demarcation. Mummification	Blood entered vein. No change in leg	Amputation eight days later. No arterial blood in vein. Death	Artery thrombosed; dark in place of anastomosis. Venae open. Ulcer cured	End-to-end by intravascular.
37	M.	Mauchère	Arch. Gen. de Chir., 1910, v. 1, 814	Gangrene extending to middle of leg three weeks, in middle of leg	No improvement	No amputation. Death one day later from embolism. Death	Artery found filled with clot at operation	End-to-end.
66	F.	Mauchère	Arch. Gen. de Chir., 1910, v. 1, 814	Gangrene of right foot (toe), spreading to leg. Acute arteriosclerosis	Anastomosis blocked. Artery healed	Death from progressive embolism in five days. Death	No report	End-to-end. Looking. Ligature of internal.

Halstead et al. Surg Gynecol Obstet 1912;14:1.

Principle and theory

- reversal of flow all the way through the capillaries improves tissue nutrition
- flow in existing collateral vessels will increase
- stimulation of angiogenesis

Ozek C, Zhang F, Lineaweaver WC, Chin BT, Newlin L, Eiman T, et al. Arterialization of the venous system in a rat lower limb model. *Br J Plast Surg* 1997;50:402e7.

Baffour R, Danylewicz R, Burdon T, Sniderman A, Common A, Graham A, et al. An angiographic study of ischaemia as a determinant of neovascularisation in arteriovenous reversal. *Surg Gynaecol Obstet* 1988;166:28e32.

Historical Data

Arteriovenous revascularization for lower limb salvage in unreconstructible arterial occlusive disease (long term outcome)

F. LENGUA, R. COHEN, B. L'HUILLIER and J.M. BUFFET (†)

1983- 1994

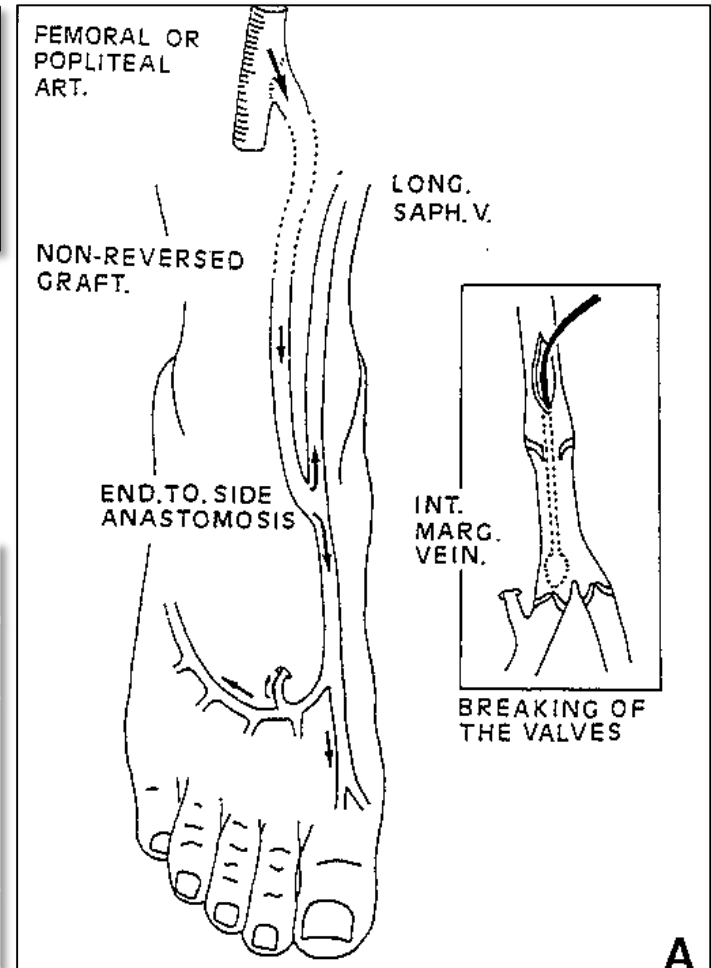
26 operations in 25 patients 74 (49-95) years

Fontaine IV 23 patients

Fontaine III 2 patients

	n	%
Number of operations	26	100
Primary success (relief of pain; minor amputation; limb salvage)	19	73
Stenosis of vein graft or fistula	11	58

Lengua et al Vasa 1995;24:261-269



Metaanalysis – current results

REVIEW

Venous Arterialisation for Salvage of Critically Ischaemic Limbs: A Systematic Review and Meta-Analysis

M.A. Schreve ^{a,*}, C.G. Vos ^a, A.C. Vahl ^b, J.P.P.M. de Vries ^c, S. Kum ^d, G.J. de Borst ^e, Ç. Ünlü ^a

	N %
studies	15
patients	768
Limb salvage 1y	75
Patency 1y	59-71

REVIEW

Meta-analysis of the Clinical Effectiveness of Venous Arterialization for Salvage of Critically Ischaemic Limbs

X.W. Lu,¹ M.M. Idu,¹ D.T. Ubbink^{1,2} and D.A. Legemate^{1*}

Departments of ¹Surgery, and ²Clinical Epidemiology and Biostatistics, Academic Medical Center, Amsterdam, The Netherlands

	N %
studies	7
patients	228
Limb salvage 1y	71
Patency 1y	46

Schreve et al Eur J Vasc Endovasc Surg 2017 53 387-402
Lu et al. Eur J Vasc Endovasc Surg 2006;31:493–499

Metaanalysis – current results

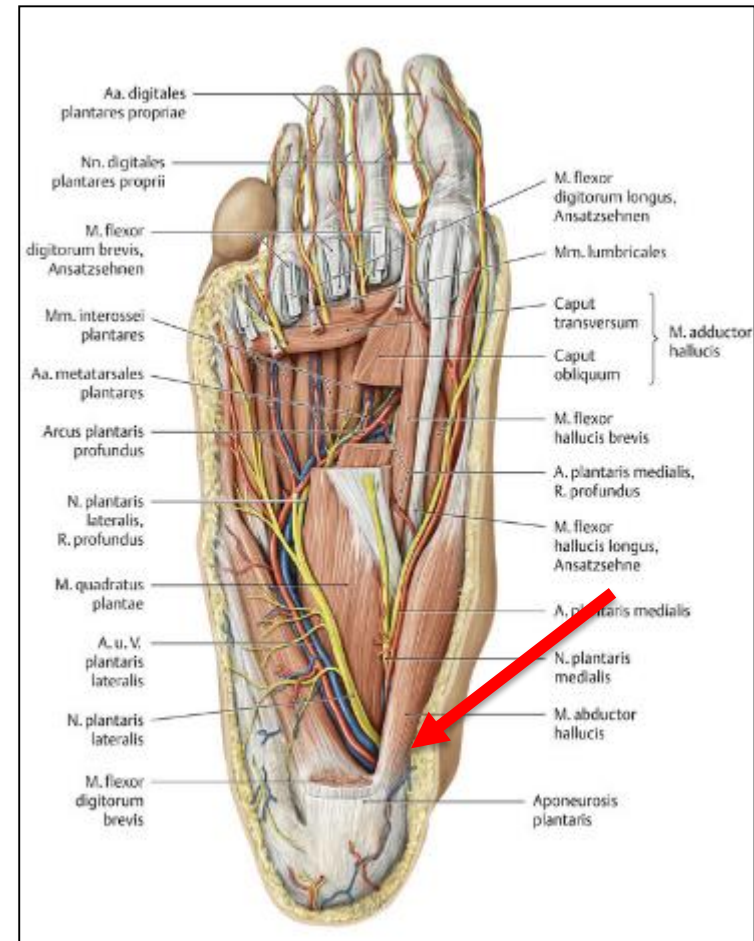
Conclusion:

the currently available evidence suggests that venous arterialisation is a **treatment option in selected patients with CLI and no arterial reconstructive options**. These otherwise unsalvageable legs can be treated with **acceptable morbidity and mortality**. However, optimization and standardisation of techniques are needed.

Schreve et al Eur J Vasc Endovasc Surg 2017 53 387-402

Patients and Method

- 01/17 until 07/18
- 8 patients with chronic foot ischemia (6 men and 2 women; 80+-2 years)
- Diabetes mellitus 8/8
- Plantar veins system exposed through a retromalleolar access
- End-to side anastomosis of vein graft to plantar vein
- Destruction of vein valves probes, antegrade valvulotome, ballon dilatation
- Follow up with duplex scan, secondary intervention if needed



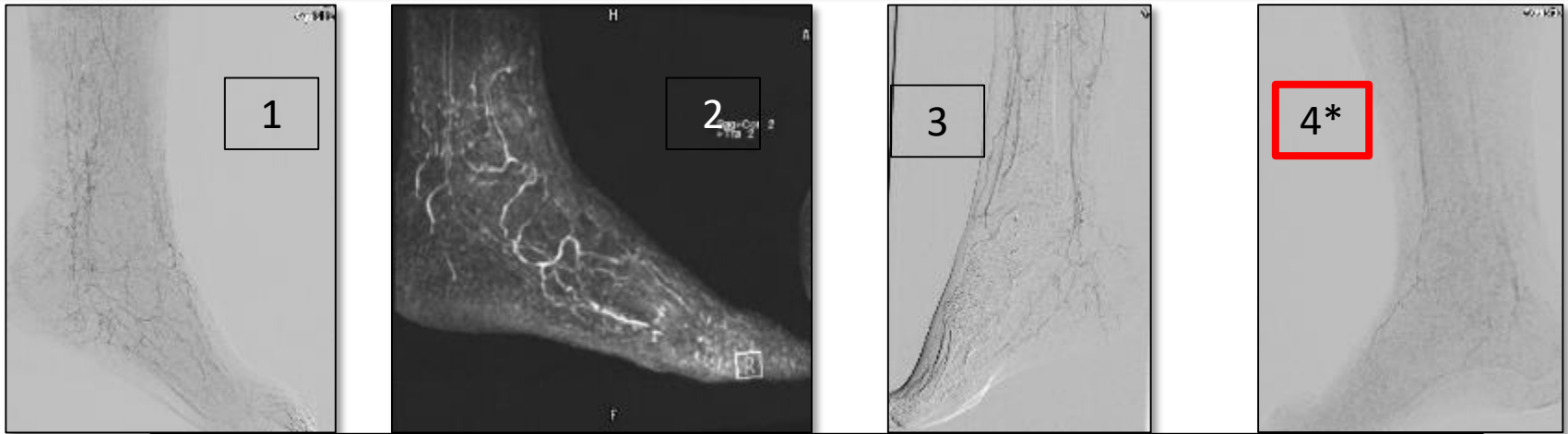
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Patients and Method

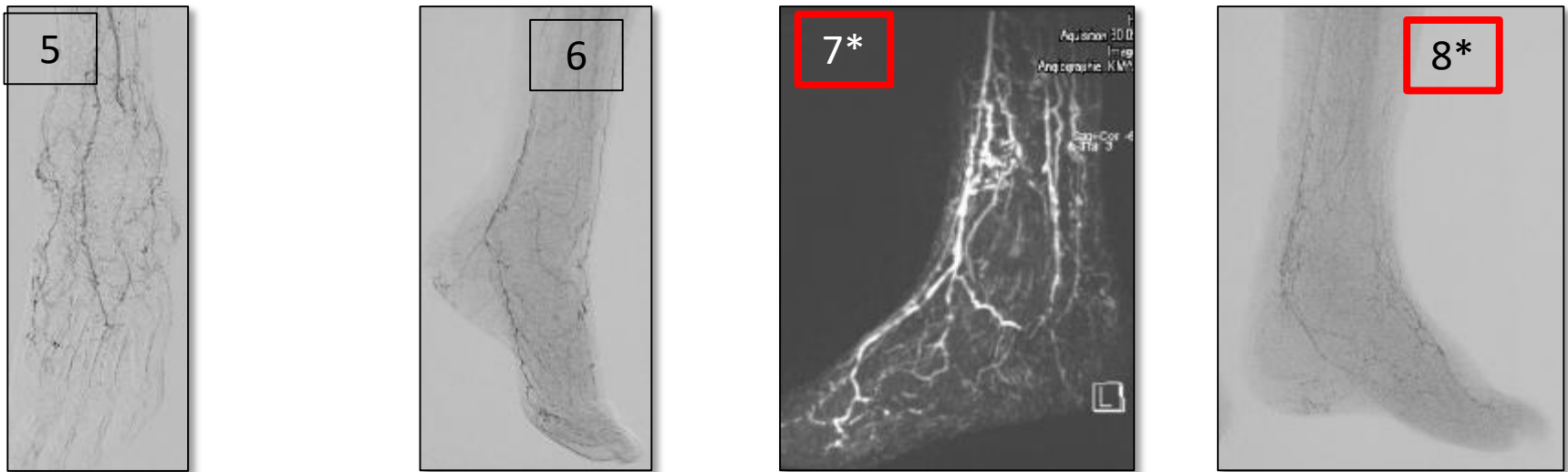
Patient	gender	age	Diabetes	Previous surgery	Previous intervention	Tissue loss
# 1	m	84	+	pedal bypass	tibial angioplasty	toe
# 2	m	77	+	-	tibial/pedal angioplasty	toe; forefoot
# 3	m	76	+	pedal bypass	-	toe
# 4	m	81	+	pedal bypass*	tibial/pedal angioplasty	superficial necrosis
# 5	m	79	+	-	tibial angioplasty	toe; forefoot
# 6	f	83	+	pedal bypass	tibial angioplasty	toe
# 7	m	74	+	pedal bypass*	-	toe; forefoot
# 8	f	84	+	pedal bypass*	-	toe

* Bail out procedure after failed bypass

Patients and Method

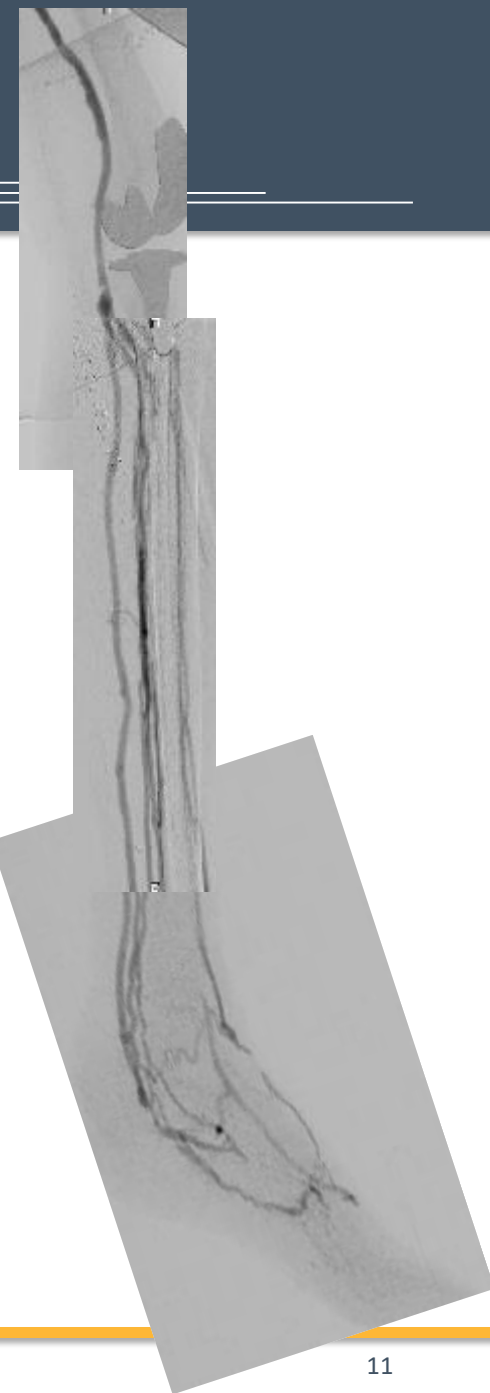


* Bail out after failed attempt of pedal bypass



Results

Patient	Proximal anastomosis	Distal anastomosis	Graft material	Bypass Flow
# 1	bk popl. a.	post. tibial vein	saphenous vein + arm vein	60
# 2	bk popl. a.	plantar vein	saphenous vein	296
# 3	profunda a.	plantar vein	PTFE + superficial femoral vein	213
# 4	bk popl. a.	plantar vein	saphenous vein	200
# 5	bk popl. a.	plantar vein	saphenous vein	249
# 6	bk popl. a.	plantar vein	saphenous vein	71
# 7	bk popl. a.	plantar vein	saphenous vein	260
# 8	bk popl. a.	plantar vein	saphenous vein	105



Results

Patient	tcPO2 preop mmHg	tcPO2 postop mmHg	Clinical success	Major amputation
# 1	14	42	+	-
# 2	9	48	+	-
# 3	8	10	-	+
# 4		34	+	-
# 5		35	+	-
# 6	13	13	-	+
# 7	20	39	+	-
# 8		20	-	+

Results: increase of tcPO2 > 30mmHg



1 toe amputation



4 complete healing



2 forefoot amputation



5 forefoot amputation

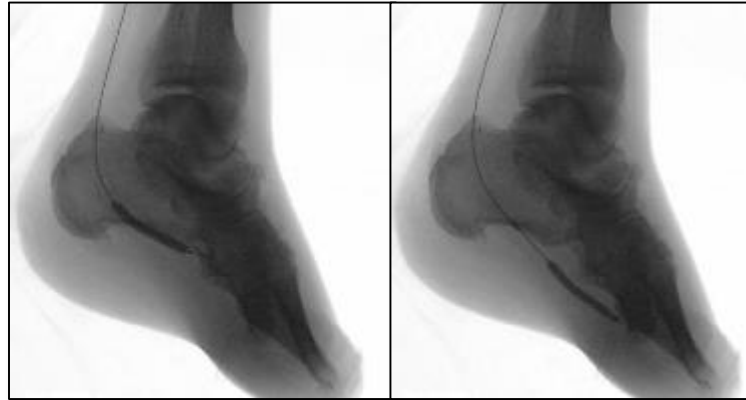


7 midfoot amputation

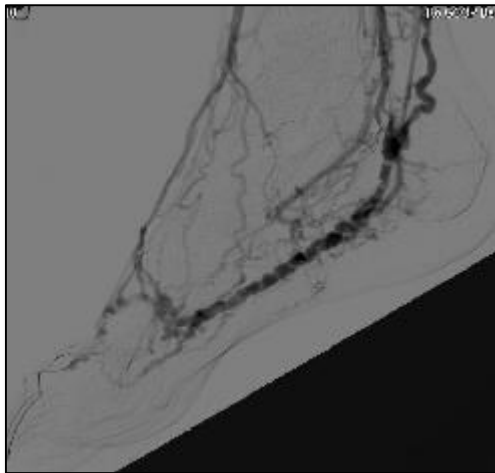
Results

Patient	Patient alive	Graft patency	Limb salvage	Level of Amputation	Secondary interventions
# 1	death 5 mo po sepsis	+	+	toe	-
# 2	alive 15 mo	+	+	forefoot	Angioplasty plantar arch
# 3	alive 11 mo	+	-	Below knee (patent bypass)	Failed angioplasty plantar arch
# 4	alive 8 mo	+	+	none	Angioplasty bypass
# 5	alive 8 mo	+	+	forefoot	Angioplasty plantar arch
# 6	alive 5 mo	-	-	Below knee	none
# 7	alive 5 mo	+	+	midfoot	none
# 8	alive 5 mo	-	-	Below knee	none

Results



PTA plantar arch with angiographic and clinical success



Failed PTA plantar arch
bk amputation



Conclusion

- Surgical arterialisation of the plantar vein system seems to be an option
- tcPO2 is improved in case of clinical success
- Wound healing is possible
- Limb salvage and freedom from pain can be achieved
- Secondary endovascular procedures may become necessary
- Last option method before major amputation?