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FLORIDA
VASCULAR
SOCIETY

# Heroic Limb Salvage Strategies: Peroneal Blind Distal Bypasses

Jorge Rey, MD

# Disclosures

- None

# Contents

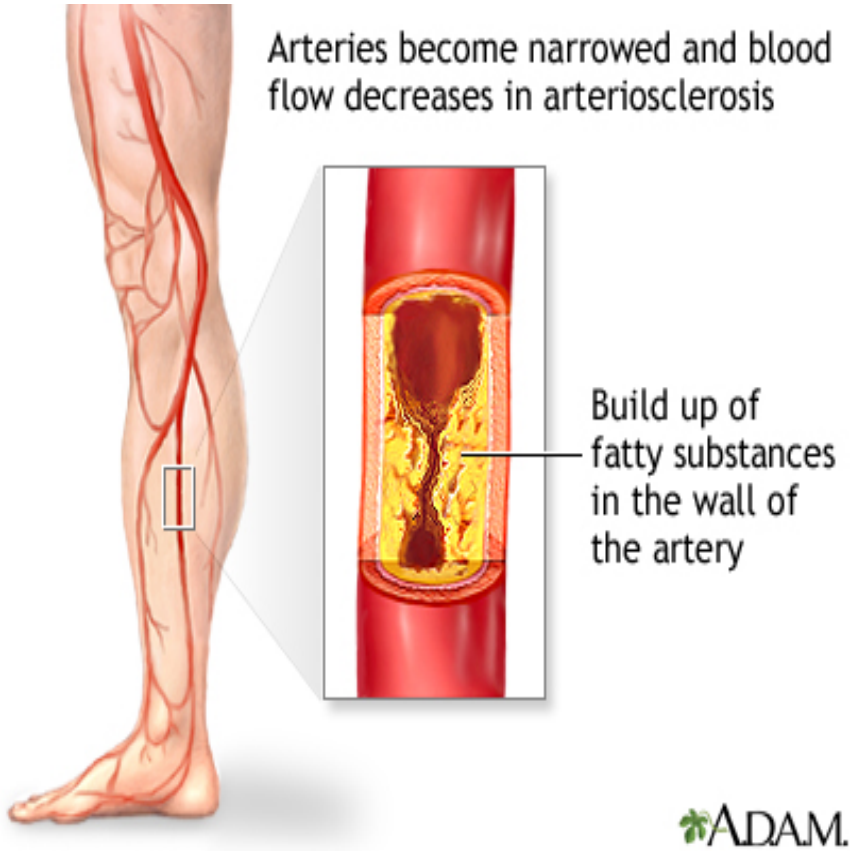
# Lower Extremity Arterial Disease

# Epidemiology

- PAD affects 12%-20% of the population older than 60 years old in the US. (1)
- Represents equal morbidity, mortality and economic burden to healthcare system than coronary heart disease and stroke. (2)
- Symptoms vary from intermittent claudication to critical limb ischemia (CLI) depending on severity and location of the lesion. (3)
- An extremity with CLI has 40% risk of amputation at 6 months after diagnosis and one-year mortality of 20-30%. (3)
- CLI occurs in <10% of all PAD patients. (4)


1. *Firnhaber, J. M., & Powell, C. S. (2019). Lower Extremity Peripheral Artery Disease: Diagnosis and Treatment. American family physician.*
2. *Peripheral arterial disease. American Heart Society. 2012.*
3. *Rutherford's vascular surgery. 7th edition*
4. *TASCII, J Vasc Surg. 2007*

# Pathophysiology and risk factors




- ✓ >65 yo: 1.5x risk for every decade
- ✓ Hypertension: 2.5x risk in men and 3.9x in women
- ✓ Diabetes mellitus: for every 1% increase in A1C, increase 28% the risk of PAD
- ✓ Hyperlipidemia
- ✓ Smoking
- ✓ Homocysteinemia

1. Cronenwett & Johnston. Chapter 104: lower extremity arterial disease. Rutherford's Vascular Surgery. Society for Vascular Surgery. 7th Edition, Vol2.
2. National Health and Nutrition Examination Survey.

# Management

- Lifestyle changes
- Exercise therapy
- Medical optimization: statins, antiplatelet, hypertension and diabetes control
- Pharmacological treatments for claudication:
  - ✓ Pentoxifylline (Trental): first FDA approved
  - ✓ Cilostazol (Pletal): FDA approved

- Revascularization indicated in:
  - ✓ Life limiting claudication
  - ✓ Rest pain
  - ✓ Tissue loss: non-healing ulcers or gangrene


1. Jaff MR, White CJ, Hiatt WR, Fowkes GR, Dormandy J, Razavi M, Reekers J, Norgren L. An update on methods for revascularization and expansion of the TASC lesion classification to include below-the-knee arteries: A supplement to the inter-society consensus for the management of peripheral arterial disease (TASC II): The TASC steering committee. Catheter Cardiovasc Interv. 2015 Oct;86(4):611-25. doi: 10.1002/ccd.26122. Epub 2015 Aug 10. PMID: 26256456.
2. Cronenwett & Johnston. Chapter 104: lower extremity arterial disease. Rutherford's Vascular Surgery. Society for Vascular Surgery. 7th Edition, Vol2.

# Revascularization

- Surgical revascularization is the standard treatment for CLI secondary to femoropopliteal disease, and a limb salvage measure for infrapopliteal disease. (1)
- Endovascular approach: preferred as initial therapy. Less invasive and proved equality in amputation-free survival compared to bypass. (2)
- Bypass surgery: performed in complex, extensive lesions, when patient has more than 2-year estimated survival. Shown to have improved patency. (2)

*Maximizing forefoot reperfusion is key for limb salvage.

Schwartz's Principles of Surgery. 10th Edition.

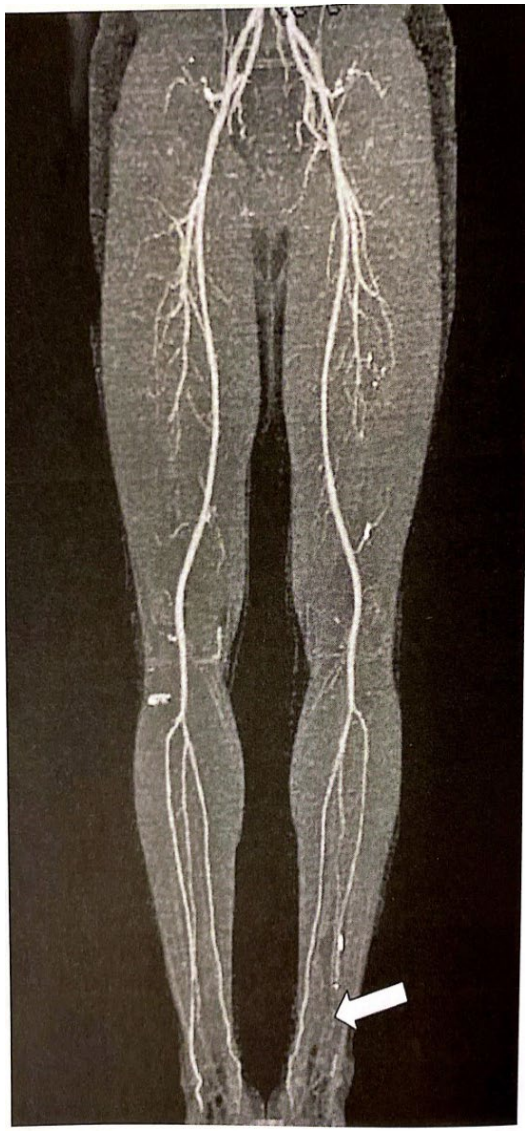


**FIG. 23-59.** A high-resolution computed tomography angiography of a patient with normal right lower extremity arterial circulation. Distal occlusive disease is noted in the left tibial arteries (*arrow*).


1. Jaff MR, White CJ, Hiatt WR, Fowkes GR, Dormandy J, Razavi M, Reekers J, Norgren L. An update on methods for revascularization and expansion of the TASC lesion classification to include below-the-knee arteries: A supplement to the inter-society consensus for the management of peripheral arterial disease (TASC II): The TASC steering committee. Catheter Cardiovasc Interv. 2015.
2. Mohapatra, A., Boitet, A., Malak, O., Henry, J. C., Avgerinos, E. D., Makaroun, M. S., Hager, E. S., & Chaer, R. A. (2019). Peroneal bypass versus endovascular peroneal intervention for critical limb ischemia. Journal of vascular surgery,.

# Considerations for bypass

- Determine:
  - ✓ Inflow vessel
  - ✓ Outflow vessel (Target vessel)
  - ✓ Type and quality of the conduit

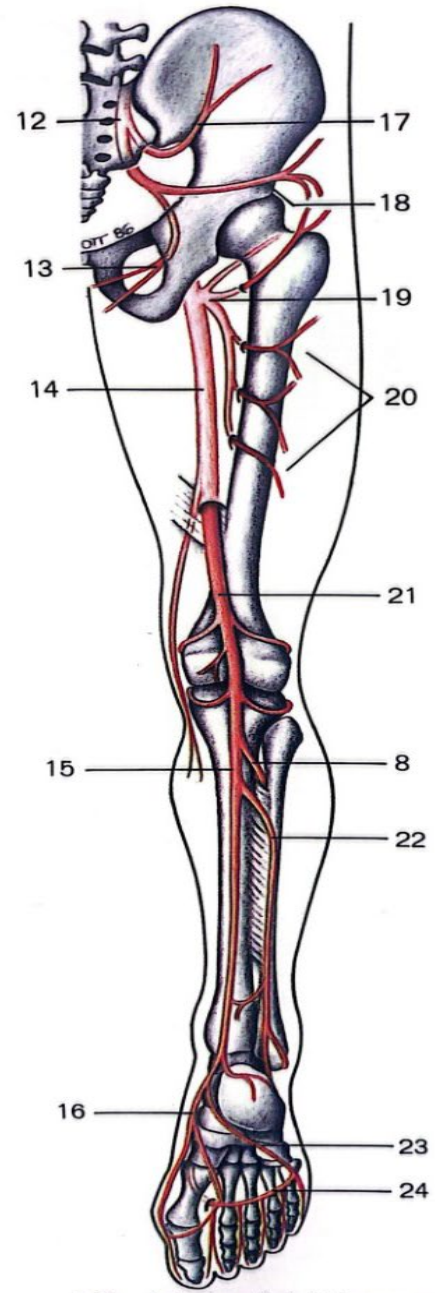
# Peroneal Artery Bypass Surgery

# Evidence for peroneal bypass

- Choose the most proximal non-diseased segments of the peroneal artery as outflow if it has direct continuity to the foot.
- Peroneal artery bypass is a durable procedure when the peroneal artery is the least diseased vessel at the infragenicular level.
- Advantages:
  - ✓ Peroneal artery is often spared of atherosclerotic disease compared to other distal vessels.
  - ✓ Peroneal artery has rich collaterals to the anterior and posterior circulation of the foot.
  - ✓ Requires shorter segment of vein/graft compared to pedal bypass.
  - ✓ Avoid performing incision on the foot, which is more prone to infections and delayed healing.

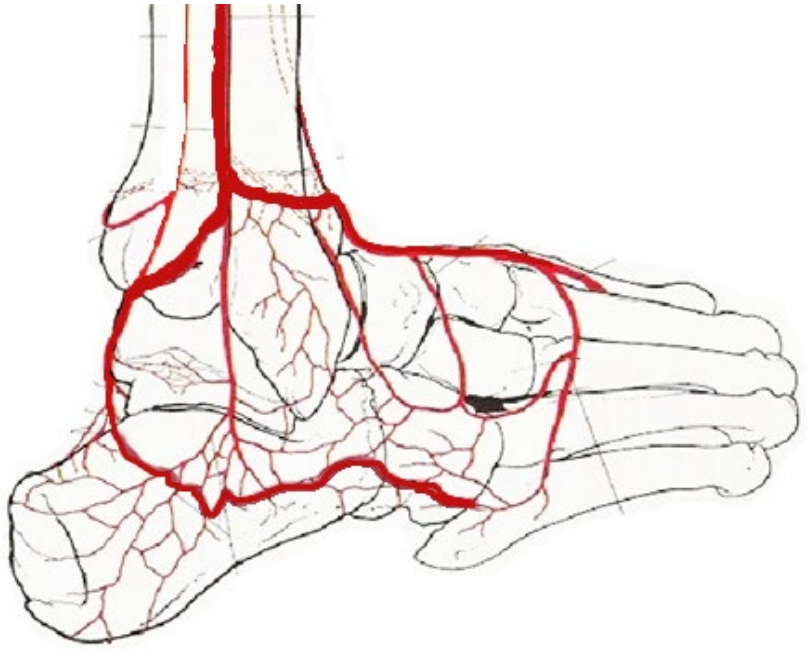

1. *Mohapatra, A., Boitet, A., Malak, O., Henry, J. C., Avgerinos, E. D., Makaroun, M. S., Hager, E. S., & Chaer, R. A. (2019). Peroneal bypass versus endovascular peroneal intervention for critical limb ischemia. Journal of vascular surgery.*
2. *Edward J. Plecha, Gary R. Seabrook, Dennis F. Bandyk, Jonathan B. Towne. (1993). Determinants of successful peroneal artery bypass, Journal of Vascular Surgery, Volume 17, Issue 1. Pages 97-106. ISSN 0741-5214.*
3. *Rutherford's Vascular Surgery. 7th Edition*


Schwartz's Principles of Surgery. 10th Edition.

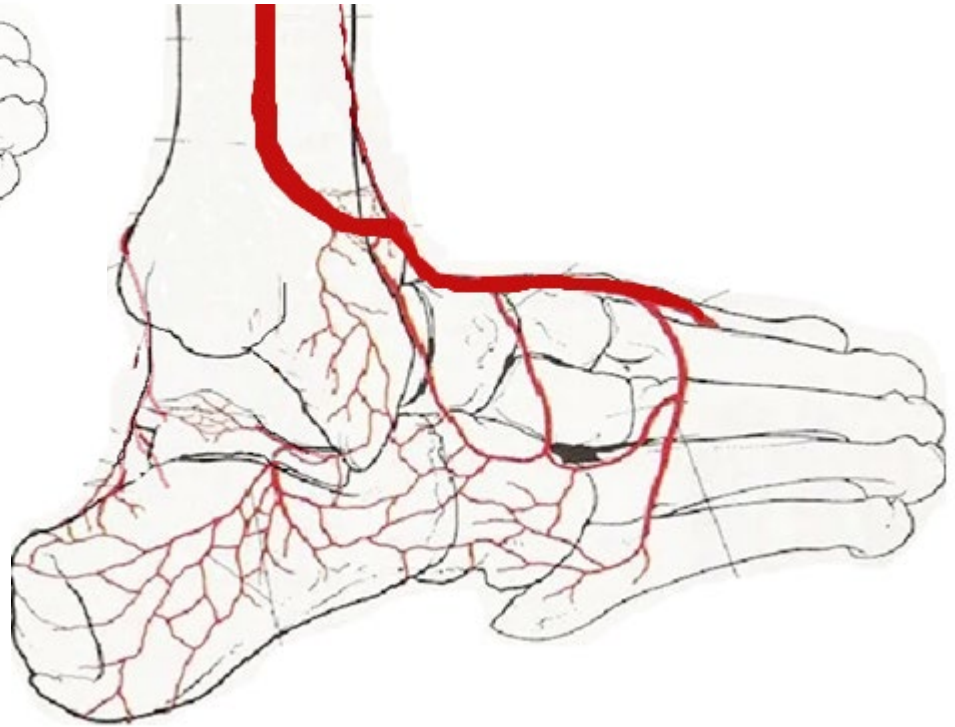



**4.68 Arteries of right lower extremity, posterior view (schematic drawing).**

# Peroneal Artery Classification

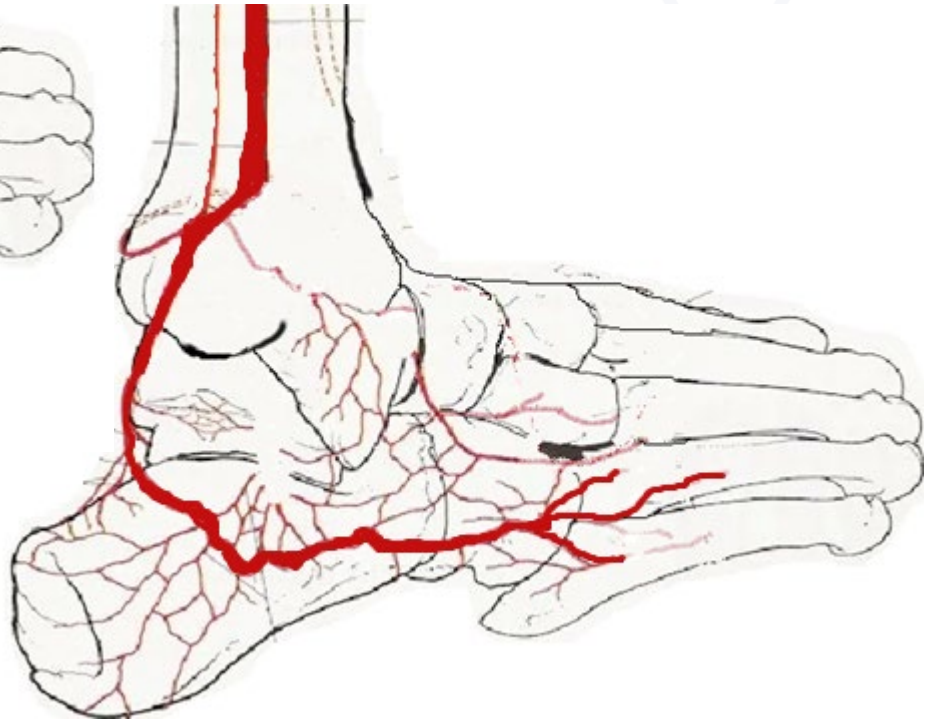


Type A:
anterior and posterior branches.

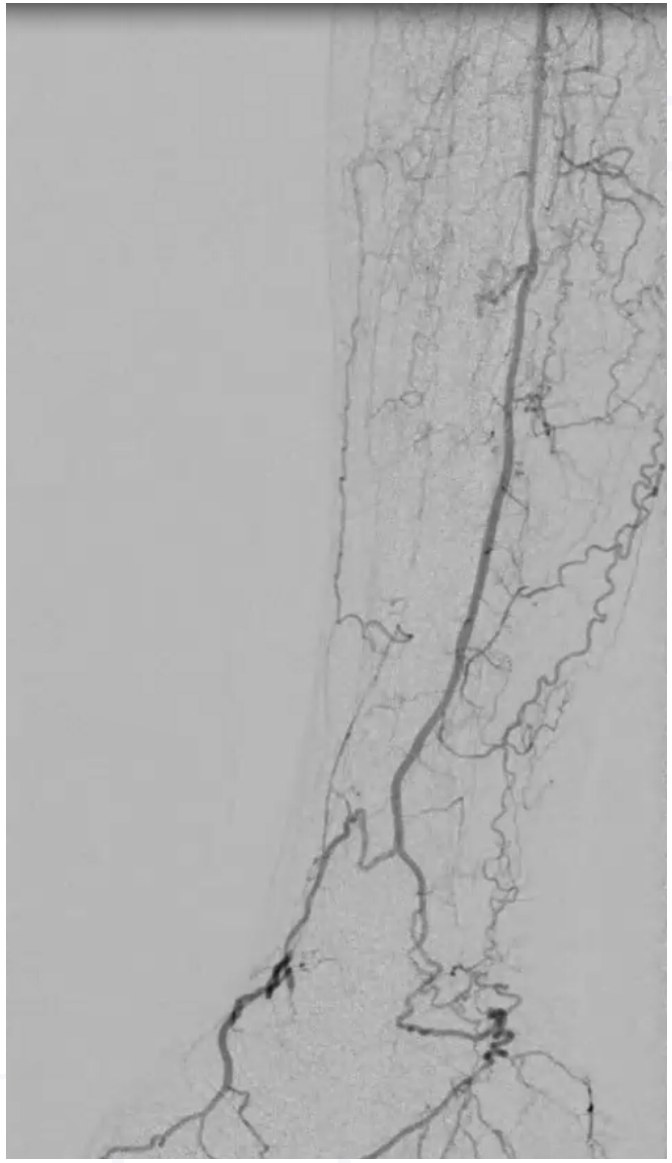


Type B:
anterior branches only

Type C:
posterior branches only

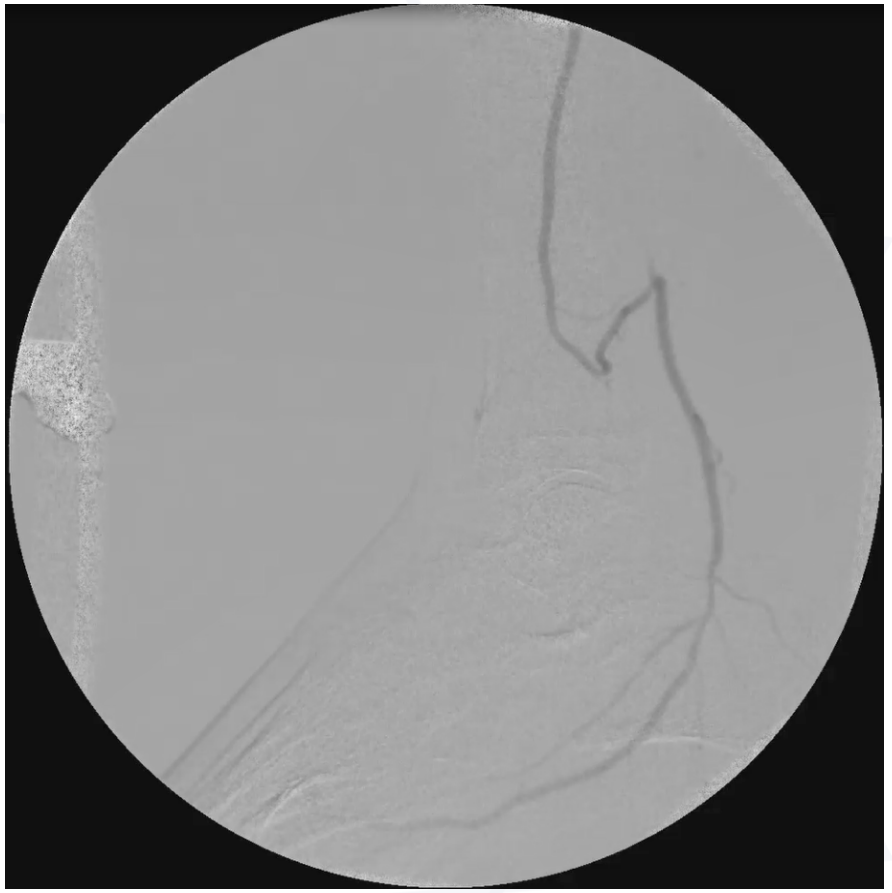


Paty PS, Darling RC, Kreienberg PB, Lloyd WE, Chang BB, Papanicolaou G, Shah DM. Determinants of Peroneal Artery Bypass Failure. Vascular Surgery Section, Albany Medical College. 32:6; 1998.

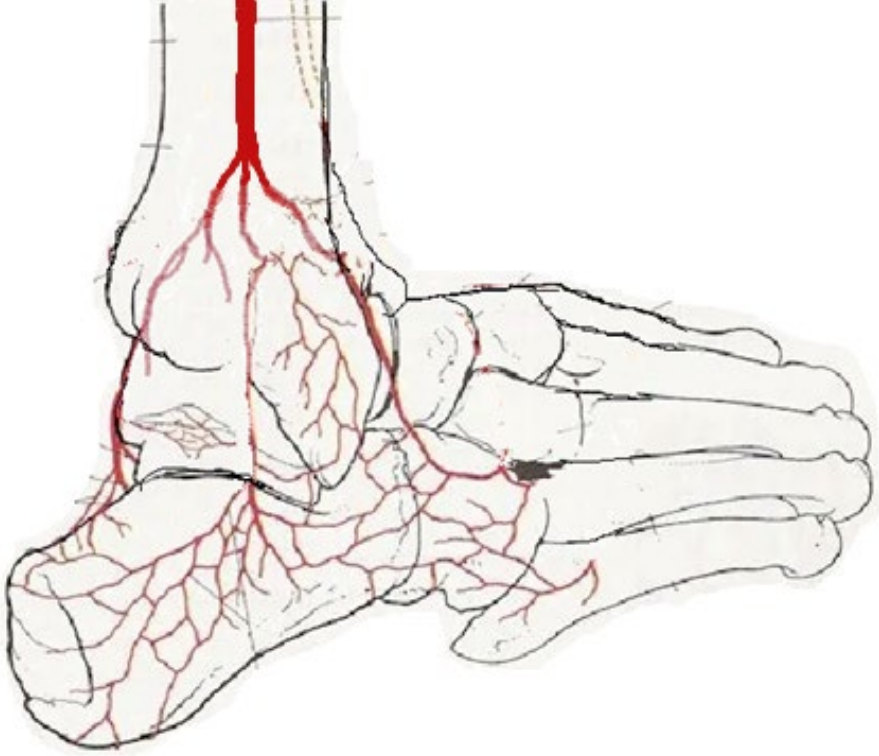


Type A:
anterior and posterior branches.

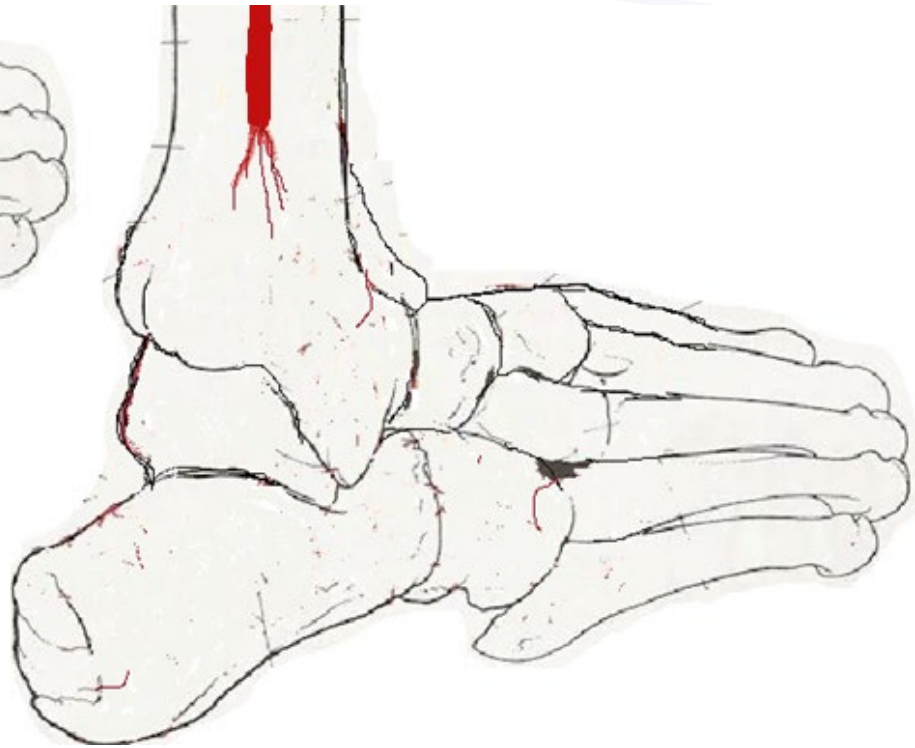
Type B:
anterior branches only



Type C:
posterior branches only

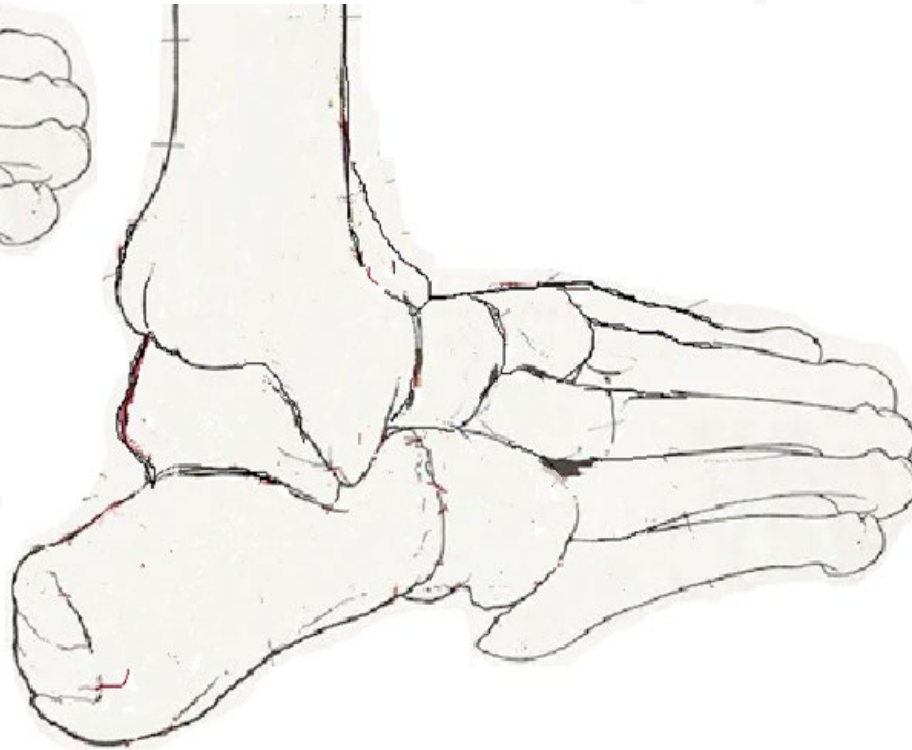


Type D:
poor/diseased distal branches



Type E:
Isolate/blind segment

Type F:
No peroneal artery visible



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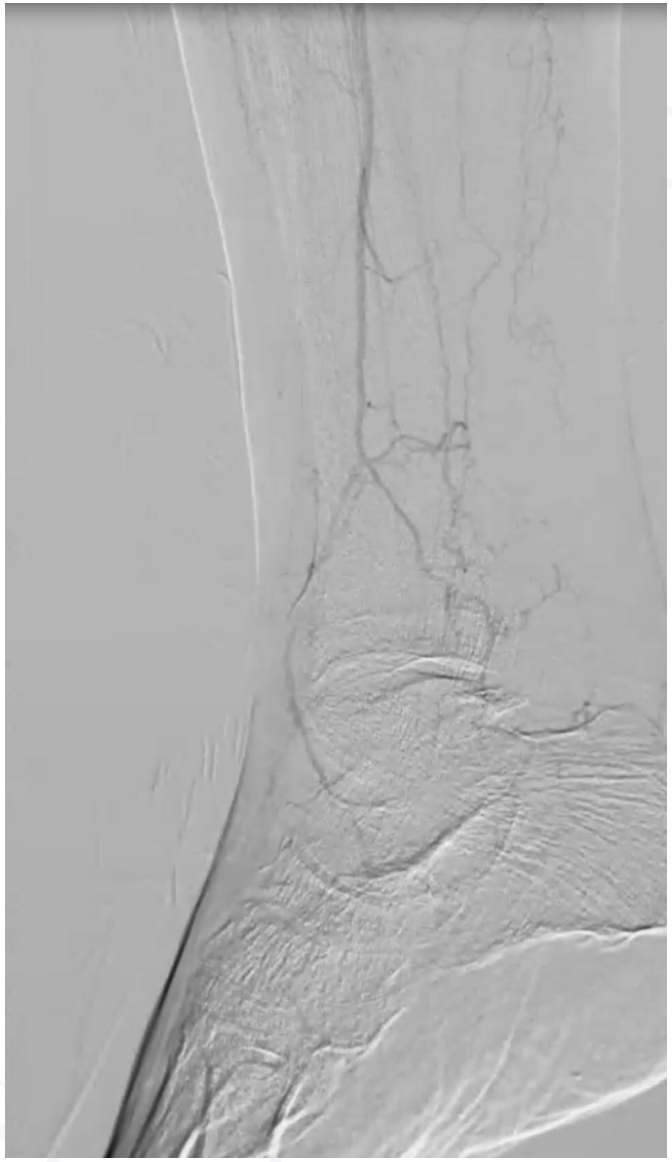

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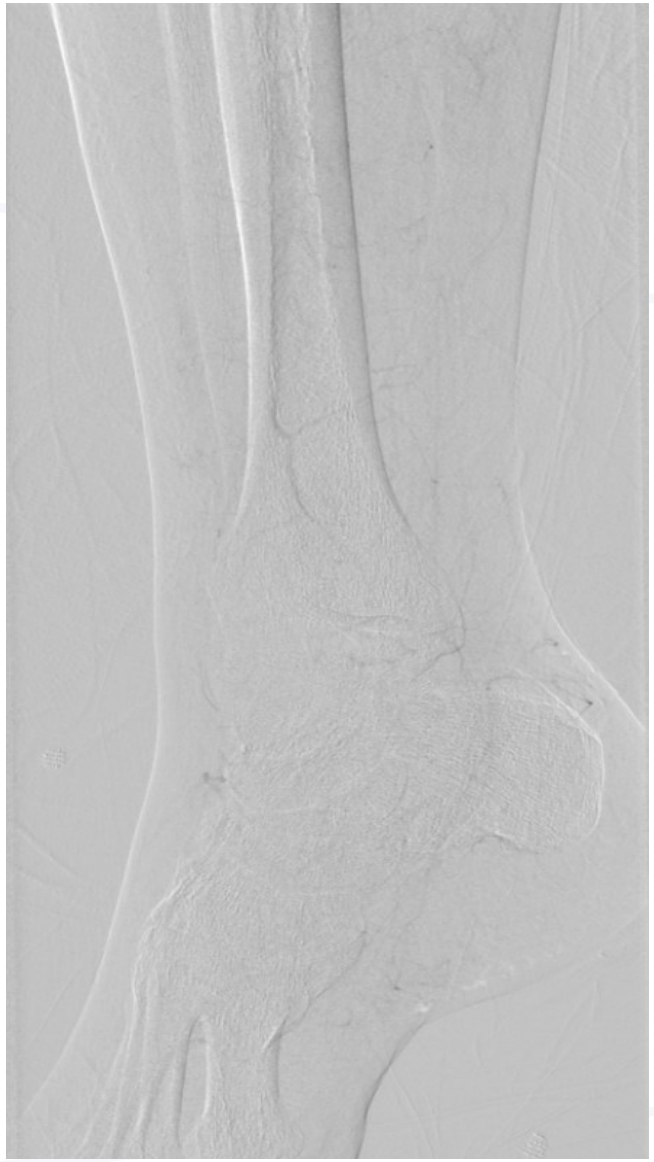
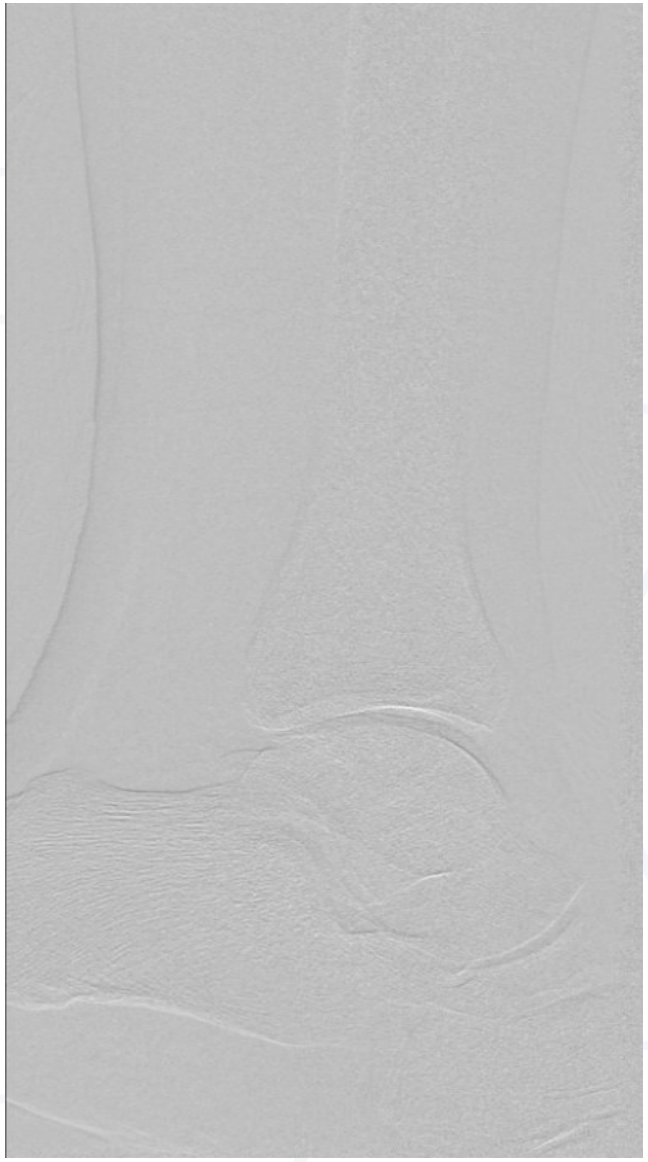


Type E:
Isolate/blind segment



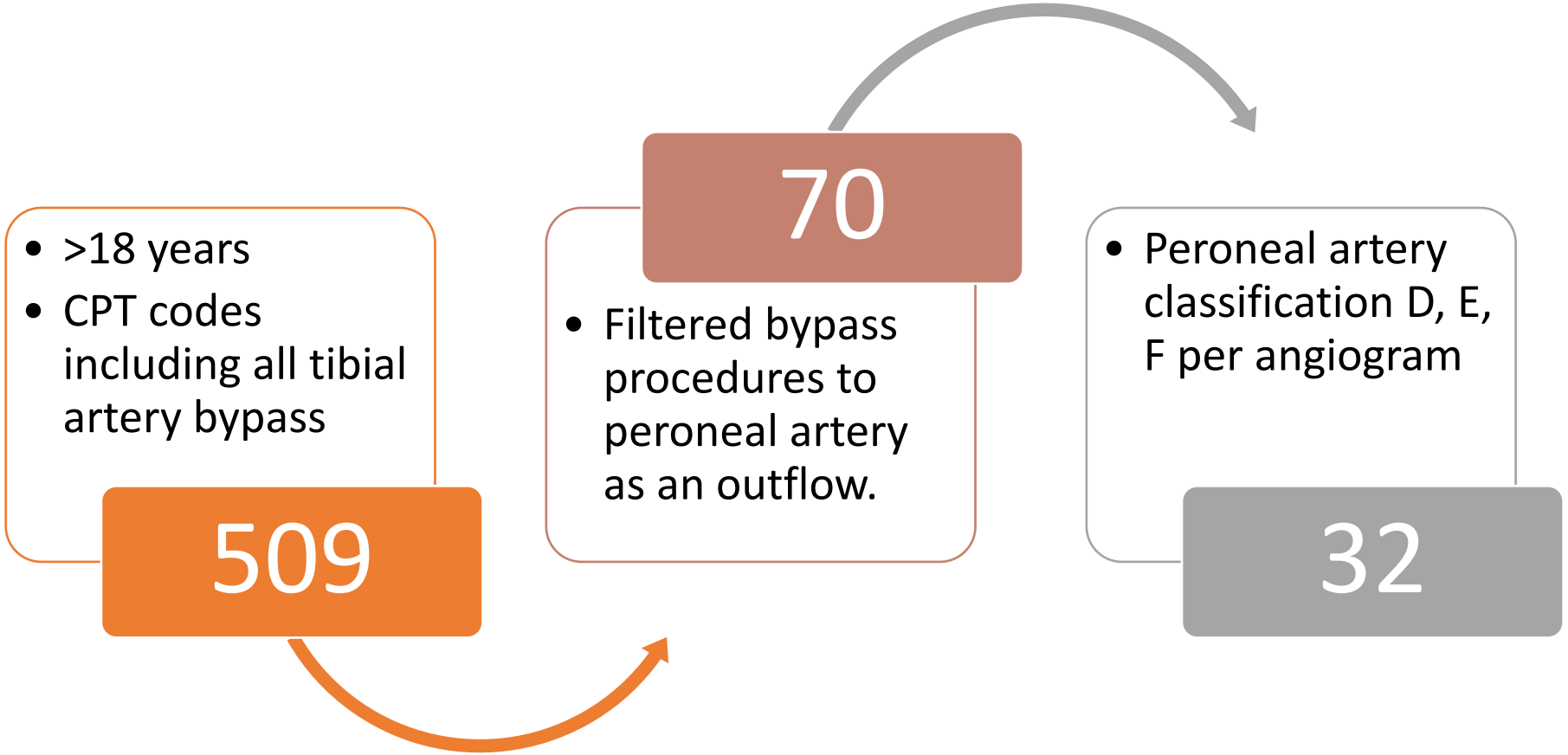
Type F:
No peroneal artery visible

# Can we achieve limb-salvage using a blind or diseased peroneal artery as outflow vessel for a bypass procedure?

# Methods

Retrospective chart review at University of Miami and Jackson Memorial Hospital for the past 10 years (2012-2022)

Inclusion/Exclusion criteria



# Methods

## Outcomes

- Limb salvage at 1 year
- Reintervention at 1 year
- Readmission rates
- Clinical improvement
- Primary patency rates
- Secondary patency rates
- Pero-operative complications

# Blind peroneal artery

| | Good Outflow n=38 (54%) | | Blind Outflow n=32 (46%) |
|---|---|---|---|
| A | 12 (31.5%) | D | 18 (56%) |
| B | 12 (31.5%) | E | 9 (28%) |
| C | 14 (37%) | F | 5 (16%) |

# Surgical characteristics

| | A-B-C n=38 | D-E-F n=32 | P-value |
|---|---|---|---|
| Inflow Vessel – N (%) | | | 0.56 |
| External iliac artery | 2 (5%) | 0 (0%) | |
| Common femoral artery | 13 (34%) | 15 (47%) | |
| Superficial femoral artery | 7 (18%) | 5 (16%) | |
| Profunda artery | 2 (5%) | 0 (0%) | |
| Above the knee popliteal artery | 6 (17%) | 9 (28%) | |
| Below the knee popliteal artery | 5 (14%) | 3 (9%) | |
| Previous bypass | 2 (5%) | 0 (0%) | |
| Proximal peroneal | 1 (2%) | 0 (0%) | |
| Conduit – N (%) | | | 0.27 |
| In situ | 9 (24%) | 3 (9%) | |
| Autogenous | 22 (58%) | 21 (66%) | |
| Non-autogenous | 7 (18%) | 8 (25%) | |

# A-B-C Vs. D-E-F

## Demographic characteristics

| | A-B-C n=38 | D-E-F n=32 | P-value |
|---|---|---|---|
| Age – in years (SD) | 67.3 (±10.39) | 65.13 (±17.44) | 0.53 |
| Sex – N (%) | | | 0.66 |
| Female | 15 (39.5%) | 11 (34.4%) | |
| Male | 23 (60.5%) | 21 (65.6%) | |
| Ethnicity – N (%) | | | 0.015 |
| Caucasian | 5 (13%) | 14 (44%) | |
| Hispanic | 24 (63%) | 12 (37%) | |
| African American | 9 (24%) | 6 (19%) | |
| Body mass index – kg/m² (SD) | 27.52 (±5.7) | 27.14 (±7.26) | 0.81 |
| Smoking – N (%) | | | 0.44 |
| Never | 11 (29%) | 11 (36%) | |
| Former | 17 (45%) | 10 (32%) | |
| Current | 10 (26%) | 10 (32%) | |
| Indication for Bypass – N (%) | | | |
| Rest pain | 9 (24%) | 5 (16%) | 0.81 |
| Tissue loss | 15 (39%) | 6 (19%) | **0.05** |
| Acute limb ischemia | 14 (37%) | 21 (65%) | **0.016** |

Comorbidities

| | A-B-C n=27 | D-E-F n=22 | P-value |
|---|---|---|---|
| Comorbidities – N (%) | | | |
| Hypertension | 34 (89%) | 25 (78%) | 0.19 |
| Diabetes Mellitus | 22 (58%) | 18 (56%) | 0.23 |
| Hyperlipidemia | 14 (37%) | 12 (37%) | 0.95 |
| Coronary Arterial Disease | 16 (42%) | 11 (34%) | 0.51 |
| Congestive Heart Failure | 4 (10%) | 2 (6%) | 0.52 |
| Asthma/ COPD | 9 (24%) | 2 (6%) | 0.05 |
| **Hypercoagulability** | 2 (5%) | 5 (15%) | 0.150 |
| Active Malignancy | 4 (10%) | 3 (9%) | 0.87 |
| Atrial Fibrillation | 6 (16%) | 4 (12%) | 0.69 |
| Chronic Kidney Disease | 6 (16%) | 4 (12%) | 0.28 |
| TIA/Stroke | 0 (0%) | 8 (25%) | 0.001 |
| Immunosuppression | 1 (3%) | 3 (9%) | 0.23 |
| HIV | 4 (10%) | 1 (3%) | 0.23 |
| Vasculitis | 1 (3%) | 0 (0%) | 0.35 |
| Pre-op medications – N (%) | | | |
| Aspirin | 22 (58%) | 13 (41%) | 0.15 |
| Plavix | 18 (47%) | 11 (34%) | 0.27 |
| Brilinta | 0 (0%) | 1 (3%) | 0.27 |
| Coumadin | 1 (3%) | 3 (9%) | 0.23 |
| Eliquis | 8 (21%) | 5 (16%) | 0.56 |
| Xarelto | 2 (5%) | 2 (6%) | 0.85 |
| Heparin | 3 (8%) | 0 (0%) | 0.10 |
| Cilostazol | 2 (5%) | 1 (3%) | 0.70 |
| Previous vascular intervention – N (%) | 30 (79%) | 20 (62.5%) | 0.79 |
| Open | 7 (23%) | 6 (20%) | |
| Endovascular | 8 (26%) | 4 (30%) | |
| Hybrid | 15 (50%) | 10 (50%) | |

# Readmissions

- Worsening and infection of foot ulcers (most common)
- Surgical site infection
- Cellulitis on the extremity
- Acute limb ischemia
- Gangrene
- Unremitting pain in the extremity
- Bleeding
- AV fistula
- Groin pseudoaneurysm

# Complications

| | A-B-C n=38 | D-E-F n=32 | P-value |
|---|---|---|---|
| Early complications – N (%) | | | |
| Occlusion of the bypass | 3 (8%) | 9 (28%) | 0.12 |
| Bypass reoperation | 4 (10%) | 3 (9%) | 0.12 |
| Bleeding | 2 (5%) | 3 (9%) | 0.50 |
| Compartment syndrome | 0 (0%) | 6 (19%) | 0.054 |
| Wound dehiscence | 3 (8%) | 3 (9%) | 0.79 |
| Late complications – N (%) | | | |
| SSI | 6 (16%) | 5 (16%) | 0.13 |
| Persistent edema | 4 (10%) | 1 (3%) | 0.23 |
| Arteriovenous fistula | 1 (2%) | 1 (3%) | 0.9 |
| **Thrombosis of the bypass** | 0 (0%) | 4 (12%) | **0.023** |
| Amputations – N (%) | 4 (10%) | 11 (34%) | 0.06 |
| Amputation-free survival time – median in days [IQR] | 228 [4-1019] | 32 [4-87] | **0.049** |
| Readmission – N (%) | 19 (53%) | 16 (52%) | 0.92 |
| Time to hospital readmission – median in days [IQR] | 47 [20-93] | 37 [25-86] | 0.45 |
| 90-day mortality – N (%) | 2 (5%) | 0 (0%) | 0.27 |

# Patency

| | A-B-C n=27 | D-E-F n=22 | P-value |
|---|---|---|---|
| **Primary patency – N (%)** | 20 (52%) | 14 (43%) | 0.46 |
| **Secondary patency – N (%)** | 25 (66%) | 19 (59%) | 0.58 |

# Limb Salvage

| | A-B-C n=38 | D-E-F n=32 | P-value |
|---|---|---|---|
| 30-day clinical improvement – N (%) | 26 (68%) | 22 (68%) | 0.78 |
| 30-day reintervention – N (%) | 11 (31.4%) | 16 (53.3%) | 0.74 |
| **1-year reintervention – N (%)** | 13 (36%) | 18 (58%) | **0.014** |
| 1-year limb salvage – N (%) | 28 (78%) | 21 (68%) | 0.087 |

*Amputations= 11
D=7, E=1, F=3

# Associations

- Female gender patients had higher risk of readmission (5.5 [1.21-25.6]; **p=0.027**), as well as African American race/ethnicity (10.38 [1.3-82]; **p=0.027**)

- Non-autogenous bypass conduit was associated with lower secondary patency rates (0.08 [0.009-0.7]; **p=0.031**)

- Blind peroneal arteries (classification D, E, F) had higher risk of amputation (7.17 [1.33-38.55]; **p=0.022**) and 1-year reintervention (3.88 [1.08-13.8]; **p=0.037**)

# Take-home messages

- When no suitable target vessel is identified through angiogram, selective exploration of distal arteries with flow detected intraoperatively may be a feasible strategy to find an adequate outflow to restore vascularization to the foot.
- More aggressive revascularization measures lead to higher chances of limb salvage.
- More evidence is needed to classify the peroneal artery and determine specific scenarios where this strategy is more successful for limb salvage.


# Thank you