

The Vascular System and It's Impact on Wound Development and Care: The Need for an Accurate Vascular Assessment

Kate Hueftle, APRN-NP, FNP-BC

1

Disclosures

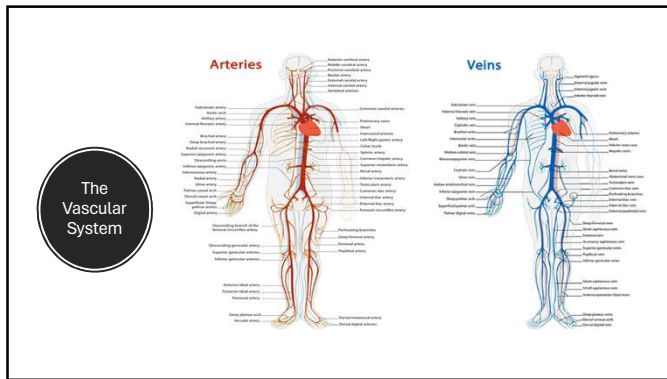
- I have no disclosures.

2

Objectives

- Describe the anatomy and function of the vascular system as it relates to its role in wound development and healing.
- Identify wounds with possible vascular etiology and the associated risk factors contributing to their development.
- Discuss potential treatment modalities and interventions aimed at addressing vascular ulcers to assist with wound healing.

3




4



5

Peripheral Arterial Disease (PAD)

- Acute (thrombosis or trauma) vs chronic (atherosclerosis)
- Macrovascular and microvascular circulation
- Critical Limb Ischemia
- Co-morbidities



Meyer, A., Schilling, A., Kott, M., Rother, U., Lang, W., & Reig, S. (2018). Open versus Endovascular Revascularization of Below-Knee Arteries in Patients with End-Stage Renal Disease and Critical Limb Ischemia. *Vascular and Endovascular Surgery*, 52(5), 613-620. doi: 10.1177/1078290318789030
Oliveira, B., Yates, T. E., Varma, S., Adeniji, O., Bouwman, R. E., & Houseworth, J. (2018, December). On the Cutting Edge: Wound Care for the Endovascular Specialist. *Semin Intervent Radiol*, 35(5), 404-436. doi: 10.1055/s-0038-1676342

6

Risk factors

PAD

- Smoking
- Age
- Diabetes
- HLD
- CAD
- Obesity
- Sedentary lifestyle
- ESRD

Chronic wounds

- Smoking
- Age
- Diabetes
- Obesity
- Sedentary lifestyle
- Venous Insufficiency
- CAD
- ESRD

7

Arterial ulcers

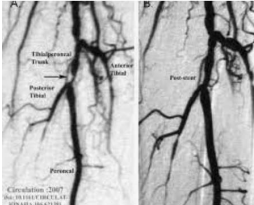
- Distal part of leg (malleoli, dorsum, toes)
- Eschar, gangrene (dry or wet)
- Punched out appearance
- Pale and low granulation appearance
- Decreased bleeding
- Deep or shallow, with exposed structures

- Health History
- Smoking status
- Decreased hair growth
- Decreased or lack of pedal pulses
- Dependent rubor
- Pain with leg elevation
- Rest pain

8

Diagnostic tests

- Non-invasive vascular labs:
 - ABI and TBI
 - Doppler segmental arterial study
 - Arterial duplex
 - TCPO2
- Radiologic imaging:
 - CT angiogram
 - MRA
 - Angiogram



9

ABI and TBI

- ABI is a non-invasive test that uses inflatable cuffs to gauge arterial circulation and measure blood pressure (systolic) between the lower extremity (DP or PT) and the upper extremity (brachial)
- Can be done quick and without expensive equipment or in accredited vascular lab
- TBI is also a non-invasive test that uses an inflatable cuff to measure blood pressure (systolic) between the great toe and the upper extremity (brachial)
- Important test to get when diabetic, CKD, and advanced age as concern for calcification of vessels



$$\frac{\text{"A"nkle}}{\text{"B"rachial}} = \text{"I"ndex}$$

Rac-Albu, M., Bluta, L., Guberna, S. M., & Sinescu, C. (2014, September). The Role of Ankle-Brachial Index for Prediction Peripheral Arterial Disease. *Medicina*, 9(3), 295-302. Retrieved March 24, 2024. From NIH Globalbase
 Heger, C., Sandemann, J., Petersen, L. J. (2013, March). The Toe-Brachial Index in the Diagnosis of Peripheral Arterial Disease. *Society for Vascular Surgery*, 3 (44).
<http://dx.doi.org/10.1016/j.jvs.2013.03.044>

10

ABI value	Interpretation	Recommendation
Greater than 1.4	Calcification/essel hardening	Refer to vascular specialist
1-1.4	Normal	None
0.9-1	Acceptable	None
0.8-0.9	Some arterial disease	Treat risk factors
0.4-0.8	Moderate arterial disease	Refer to vascular specialist
Less than 0.4	Severe arterial disease	Refer to vascular specialist

Segment	Wavform	Pressure	PI	PVR	Wavform	Pressure	PI	PVR
Brachial A	Trifurcate	142	0.82		Trifurcate	152	1	
DPA	Trifurcate				Trifurcate			
POA A	Trifurcate				Trifurcate			
Ankle PT1 Posterior Tibial	Trifurcate	155	0.99	Good	Trifurcate	150	0.99	Good
Ankle PT2 Dorsalis Pedis	Trifurcate	134	0.88	Good	Trifurcate	142	0.88	Good
Big Toe	IC	124	0.84	Fair	IC	78	0.5	Fair

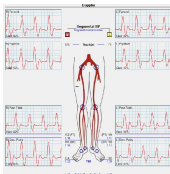
Right lower extremity ABI: 0.99
 Left lower extremity ABI: 0.99

Range	Interpretation
> 0.75	Normal
0.5 – 0.75	Mild
0.35 – 0.5	Moderate
0.25 – 0.35	Moderate-Severe
< 0.25	Severe

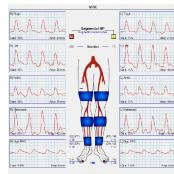
11

Doppler arterial study with PVR

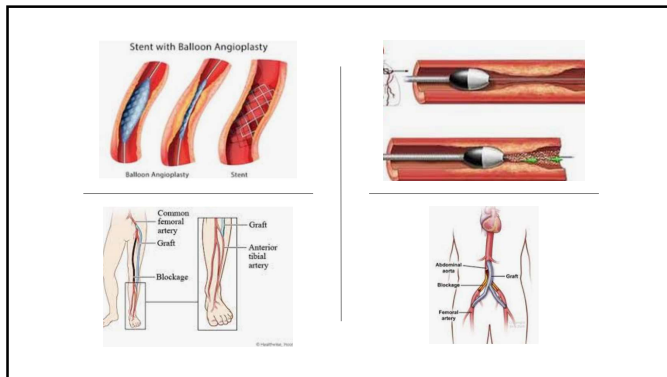
Segmental Doppler



Pulse Volume Recording



12



16

Venous Insufficiency

- Estimated over 2.5 million Americans experience chronic venous disease
- Approximately 20% experience venous stasis ulcer
- VLU recurrence rate up to 70%
- Valvular incompetence

Normal Venous Function

Venous Reflux

Singh A, Zahra F. Chronic Venous Insufficiency. (2023 April). StatPearls Publishing. Retrieved March 24, 2024 from <https://www.ncbi.nlm.nih.gov/books/NBK587341/>

17

Risk Factors

- Trauma (crush, surgery)
- DVT
- Recurrent infection
- Lifestyle
- Congenital venous abnormality
- Limited mobility (impaired calf pump)
- HF
- Family history

- Pregnancy
- Age
- Mixed disease
- Where sleeping
- OSA
- Obesity

18

Intervention

Non-surgical

- Compression
- Exercise
- Pumps
- Referral to PT or lymphedema therapy
- Sclerotherapy

Surgical

- Vein ablation
 - Radiofrequency
 - Laser
- Medical glue
- Stab phlebectomies
- Stents

22



23

Case Study



- PmHx: HLD, statin intolerance, tobacco use of 1 ppd for 40+ years, history of trauma to RLE including transection of right popliteal artery
- Surg Hx: Right knee replacement (multiple revisions), pelvic fixation with right femur and ankle ORIF, right SFA-popliteal bypass with contralateral GSV and fasciotomies

24

Case Study

Subjective:

- RLE has always felt "cool" since his trauma with chronic pain
- Lacks sensation in foot since trauma and surgeries
- Unable to tell if walking distance decreased
- Leg swelling worsening, right worse than left
- Has tried compression but too painful
- Leg elevation hurts
- Sleeping in chair with legs dependently down

Objective:

- Unable to palpate pedal pulses
- RLE cool to touch
- Significant swelling to BLE
- Wound to right pre-tibial area that is irregularly shaped, superficial, wound bed mix of yellow slough/fat necrosis, gangrene, and red tissue
- Peri-wound skin red and violaceous with scattered reticular/telangiectasia veins
- Pack of cigarettes hanging out of shirt pocket
- Contrast allergy
- Compliance

25

Case Study

Pressure Indexes

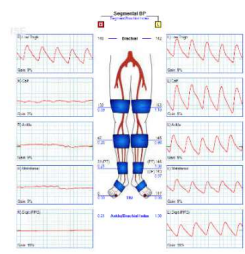
	Right	Indices	Brachial	Left	Indices
Brachial	140mmHg		140mmHg		
Low Thigh	120mmHg	0.89	Low Thigh	105mmHg	1.10
Calf	42mmHg	0.28	Calf	145mmHg	0.88
Ankle/PT	27mmHg	0.21	Ankle/PT	140mmHg	1.00
Ankle/DVT	0mmHg	0.00	Ankle/DVT	145mmHg	0.97
Digit	0mmHg	0.00	Digit	147mmHg	0.99
ABI	0.21		ABI	1.00	

Conclusion

1. Distal femoral-popliteal bypass graft with at least 50% of the proximal graft without a definitely visualized distal anastomosis, possibly occluded.
2. Occlusion of the popliteal artery, the anterior tibial artery, and non-visualization of the peroneal concerning for occlusion.
3. Monophasic waveform in the distal posterior tibial artery suggestive of significant upstream narrowing.

Conclusion

No ultrasonographic evidence of DVT in the right or left lower extremity.
The left greater saphenous vein is absent consistent with prior surgical harvesting.
The right greater saphenous vein is dilated measuring a maximal diameter of 13 mm and demonstrating prolonged axial reflux.
The left distal saphenous vein measures a maximal diameter of 8 mm and demonstrates prolonged axial reflux.
Incompetent perforating branch vessel about the left ankle with prolonged axial reflux.
Deep venous insufficiency is noted in the left common femoral vein along with the bilateral femoral and popliteal veins.



26

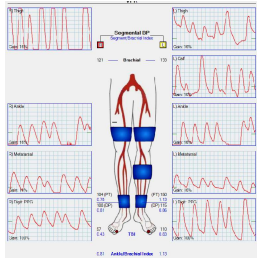
Case Study

Treatment:

- Get wound bed dry until arterial flow can be improved
- No compression until arterial flow can be improved
- Passive warming
- Work on smoking cessation
- RLE angiogram showed occlusion of the SFA and popliteal arteries, unable to visualize anterior and peroneal arteries. 1 vessel runoff via PT artery
- Vein mapping for bypass options
- Right femoral to proximal posterior tibial artery bypass with reverse GSV, along with excisional I&D of the wound

27

Case Study



- Patient stated his leg has never felt as warm as it did post bypass
- Overall pain starting to reduce
- Able to sleep in bed
- Improvement in leg swelling
- Walking more
- Wound slowly healing
- Down to less than ½ ppd
- Indifferent on compression use

28

Case Study



29

References

- Andrews, K. L. & Wolf, L. L. (2015). Vascular Diseases. *Braddom's Physical Medicine and Rehabilitation*. 543-546. <http://ebookcentral.proquest.com/lib/unmc/detail.action?docID=4187432>
- Goldman, R. J., de Leon, J. M., Popescu, A., & Salcido, R. (2015). Chronic Wounds. *Braddom's Physical Medicine and Rehabilitation*. 511-542. <http://ebookcentral.proquest.com/lib/unmc/detail.action?docID=4187432>
- Hoyer, C., Sandermann, J., & Petersen, L. J. (2013, March). The Toe-Brachial Index in the Diagnosis of Peripheral Arterial Disease. *Society for Vascular Surgery*, 3 (44). <http://dx.doi.org/10.1016/j.jvs.2013.03.044>
- Li, W. W., Carter, M. J., Mashlach, E., & Guthrie, S. D. (2017). Vascular Assessment of Wound Healing: A Clinical Review. *International Wound Journal*, 14, 460-469. Doi: 10.1111/iwj.12622
- Meyer, A., Schilling, A., Kott, M., Rother, U., Lang, W., & Regus, S. (2018). Open versus Endovascular Revascularization of Below-Knee Arteries in Patients with End-Stage Renal Disease and Critical Limb Ischemia. *Vascular and Endovascular Surgery*, 52(8), 613-620. doi: 10.1177/1538574418789036
- Olivieri, B., Yates, T. E., Vianina, S., Adenikinju, O., Beasley, R. E., & Houseworth, J. (2018, December). On the Cutting Edge: Wound Care for the Endovascular Specialist. *Semin Intervent Radiol*. 35(5), 406-426. doi: 10.1055/s-0038-1676342
- Rac-Albu, M., Iluta, L., Guberna, S. M., & Sinescu, C. (2014, September). The Role of Ankle-Brachial Index for Prediction Peripheral Arterial Disease. *Medica*, 9(3), 295-302. Retrieved March 24, 2024, from NIH database
- Singh A, Zahra F. Chronic Venous Insufficiency. (2023 April). StatPearls Publishing. Retrieved March 24, 2024 from <https://www.ncbi.nlm.nih.gov/books/NBK587341/>

30