

Introduction

Chronic wounds, including diabetic foot ulcers and venous leg ulcers, impact up to 10.5 million Medicare beneficiaries—approximately 2.5% of the total population of the United States.¹ Adequate tissue perfusion is critical for healing. Yet standard vascular diagnostics (ankle-brachial index [ABI], toe-brachial index [TBI], and transcutaneous oxygen pressure [TcPO₂]) often fall short in assessing real-time microvascular status at the wound bed.⁴⁻⁵ Multispectral near-infrared spectroscopy (NIRS) imaging non-invasively measures tissue oxygen saturation (StO₂) in real time at and around the wound bed. While promising, its correlation with conventional diagnostics remains underexplored. The purpose of this study is to evaluate the correlation between NIRS-derived StO₂ and standard vascular diagnostic tests.

Demographic and Clinical Characteristics of Study Participants

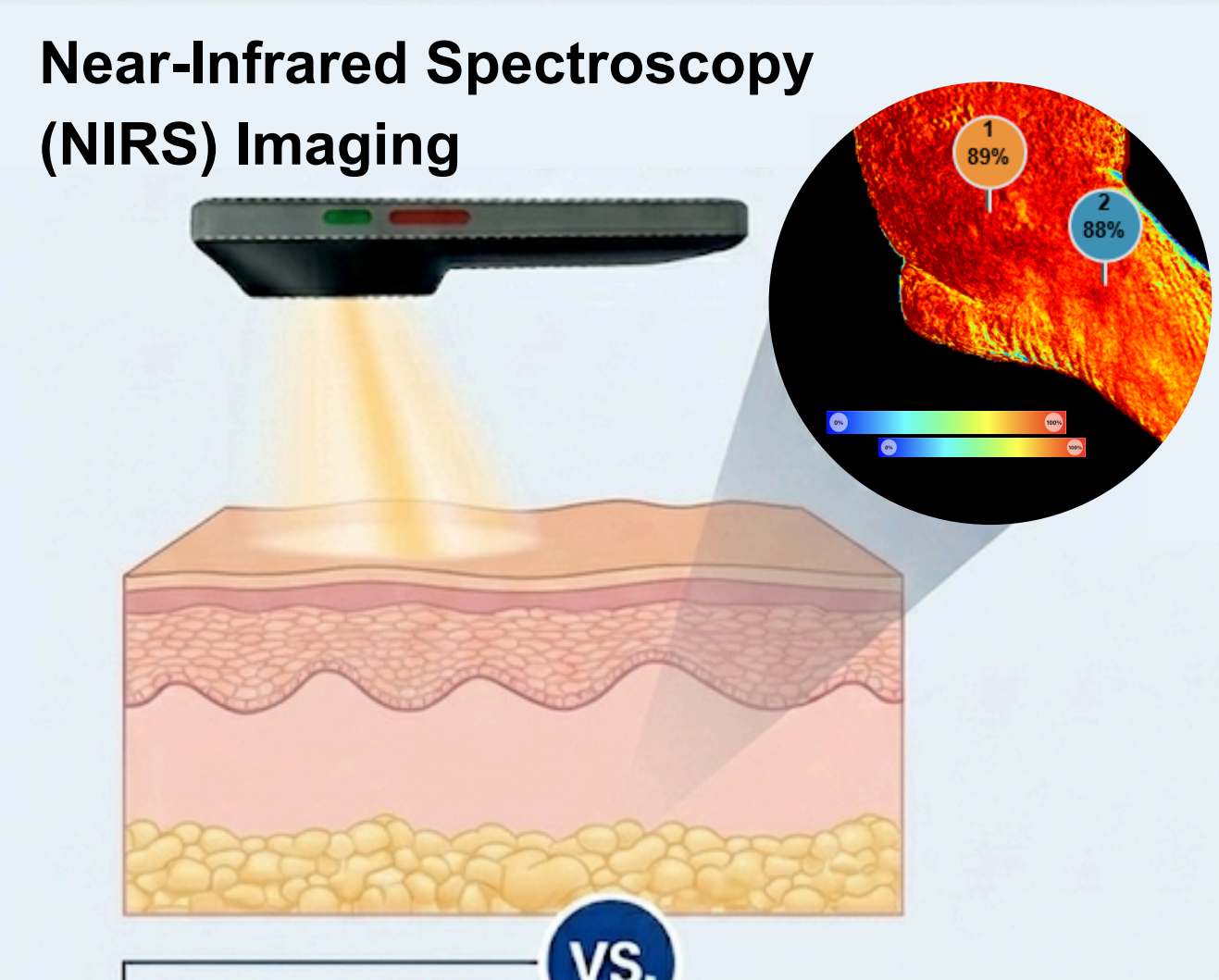
Participant baseline demographic characteristics		Participant Baseline Comorbidities		Participant Baseline Wound Characteristics	
Demographic Details	Statistics (n = 18)	Comorbidity	No. (%)	Wound Baseline Characteristics	Statistics (n = 18)
Age at consent (years), mean ± SD	65.8 ± 18.4	Diabetes Mellitus (DM)	None: 10 (55.6%) Type 2: 8 (44.4%)	Wound Presence, n (%)	15 (83.3%)
Gender (self-reported), n (%)	Female: 11 (61.1%) Male: 7 (38.9%)	Hypertension (HTN)	Present: 10 (55.6%) Absent: 8 (44.4%)	Mean Dimensions (cm), mean ± SD	Length: 53.4 ± 190.8 Width: 5.6 ± 11.6 Depth: 0.4 ± 0.4
Body mass index (BMI), mean ± SD	29.5 ± 8.0	Peripheral Vascular Disease (PVD)	CVI: 7 (38.9%) PAD: 2 (11.1%) No: 9 (50.0%)	Primary Etiology, n (%)	Diabetic Foot Ulcer (DFU): 5 (33.3%) Venous Leg Ulcer (VLU): 5 (33.3%) Pressure Injury (PI): 1 (6.7%) Traumatic: 3 (20.0%) Pyoderma Gangrenosum (PG): 1 (6.7%)
Fitzpatrick score (FS), n (%)	FS I: 6 (33.3%) FS II: 4 (22.2%) FS IV: 2 (11.1%) FS V-VI: 6 (33.4%)				

CVI: Chronic Venous Insufficiency; PAD: Peripheral Artery Disease

Note: Large SD in length reflects high variance in wound morphology across the heterogeneous patient cohort.

Methods

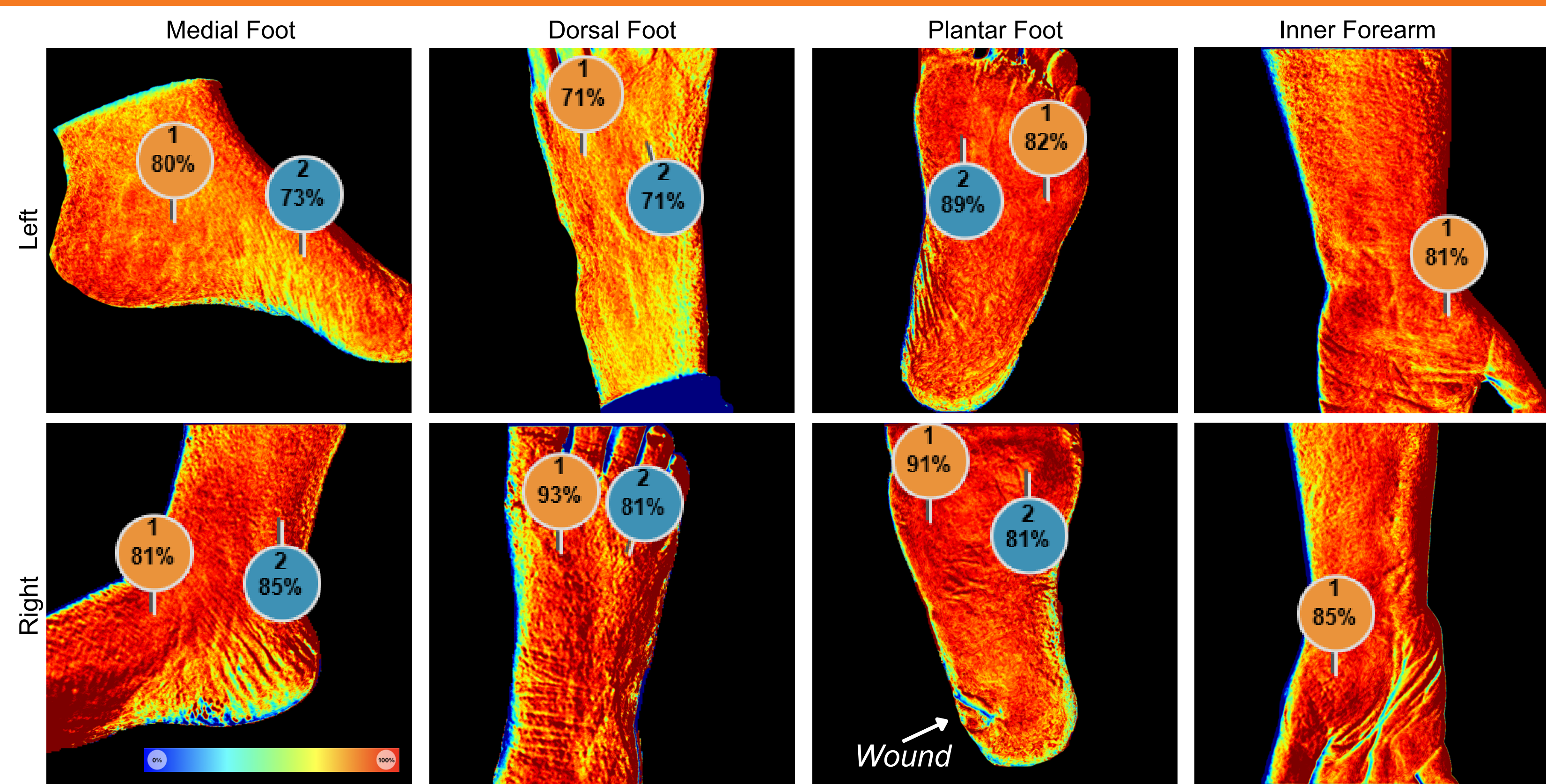
This ongoing REB-approved, single-center, prospective observational study enrolled 40 adults (≥18 years) with lower extremity wounds, of which 18 cases are included here. Each participant underwent NIRS imaging across multiple foot planes (plantar, dorsal, lateral) on both feet, with wounds imaged when present, and the palm of the hand included as a control, alongside standard assessments: ABI, TBI, DUS, and TcPO₂.



Comparative analysis of NIRS-derived StO₂ mapping versus standard vascular diagnostics (ABI, TBI, DUS, TcPO₂).

- Ankle-Brachial Index (ABI)
- Toe-Brachial Index (TBI)
- Duplex Ultrasound (DUS)
- Transcutaneous Oxygen Pressure (TcPO₂)

Case Example



A 47-year-old non-smoking female (Fitzpatrick Skin Type I) with Type 2 Diabetes Mellitus presented with a Right Plantar DFU and no history of PVD.

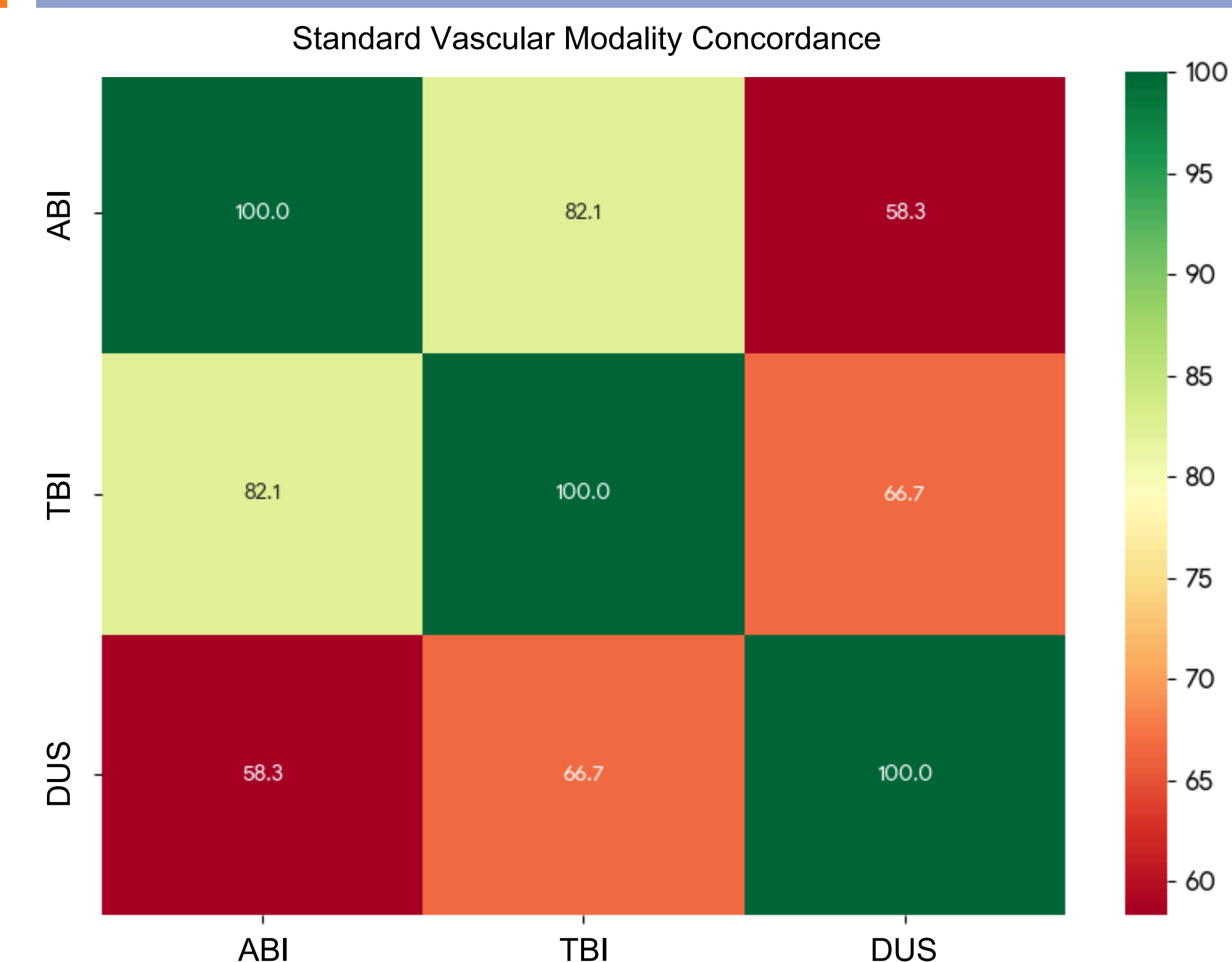
- **ABI/TBI:** Macrovascular flow appears compensated with an ABI of 0.99 (L) and 0.80 - both normal. However, the Left TBI of 0.69 indicates mild arterial impairment, contrasted by a normal 0.77 (R).
- **Doppler:** Waveforms are consistently biphasic, suggesting moderate attenuation of arterial elasticity.
- **TcPO₂:** A discrepancy is noted between the Right Dorsal Foot (105 mmHg) and the Left Dorsal Foot (26 mmHg), the latter indicating impaired microcirculation.

NIRS Imaging Correlation - bilateral differences in StO₂

- Left Foot: Correlating with the abnormal TBI and low TcPO₂
- Right Foot: Despite the active plantar ulcer, the right foot maintains higher perfusion levels

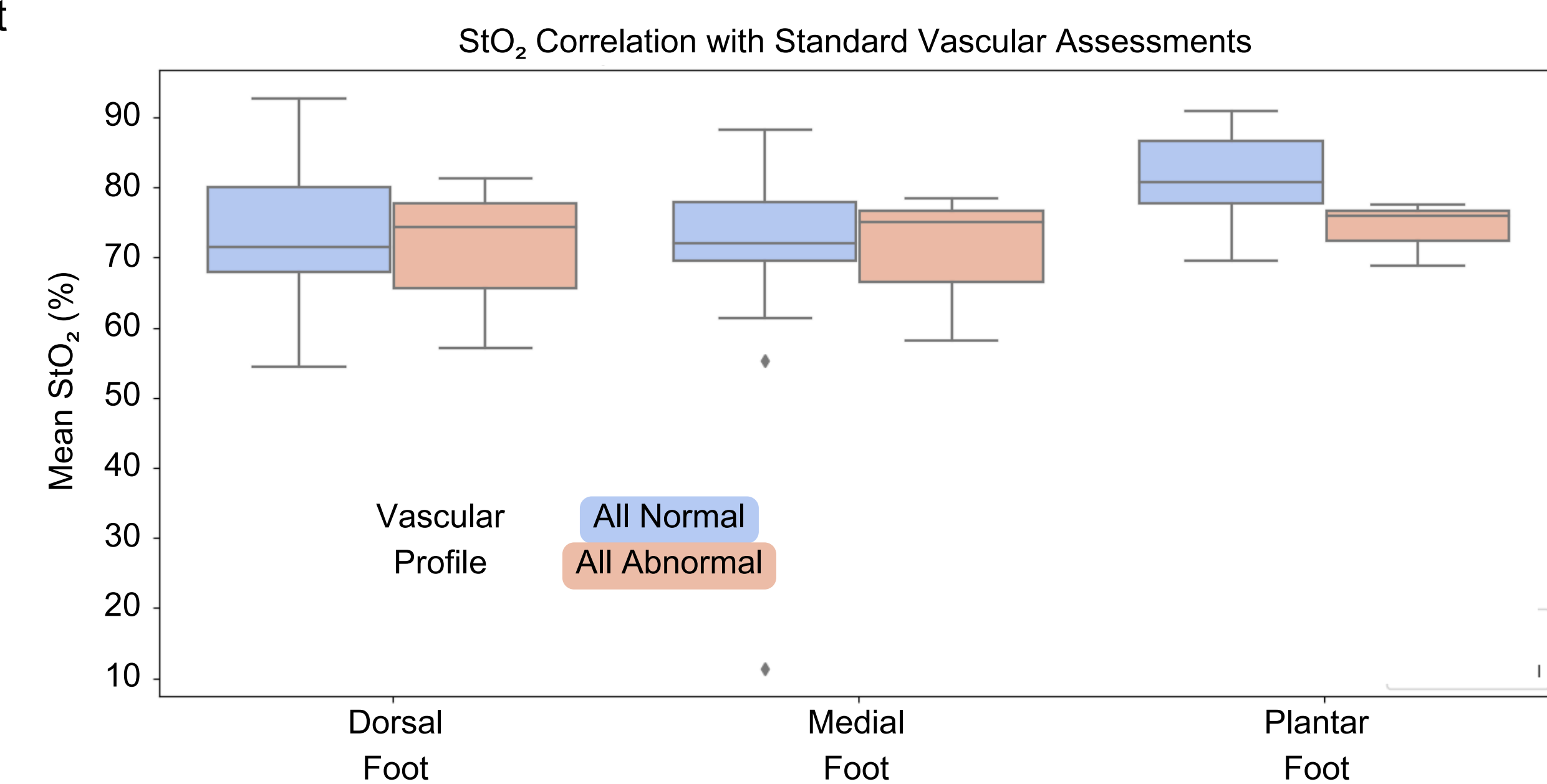
Conclusion: While the right plantar ulcer is the primary clinical focus, the left foot exhibits objective signs of microvascular and macrovascular compromise.

Main Results



Comparison of clinical categories across ABI, TBI, and Doppler Ultrasound (DUS). The high rate of discordance (39.5%) highlights cases where a "Normal" ABI masks underlying condition, such as with mild-to-moderate TBI or abnormal arterial waveforms.

- In patients with calcified vessels, ABI values appear falsely "Normal" or "Incompressible"
- Because digital (toe) arteries are less prone to calcification, TBI and DUS serve as more reliable markers.



Regional StO₂ Distribution. This figure illustrates the distribution of StO₂ across 3 anatomical reference sites. While absolute values provide a baseline, the clinical utility of this data relies on a comparative diagnostic approach - Bilateral Comparison, Anatomical Gradient (Dorsal vs. Plantar), Body Part Normalization (Palm/Forearm to Plantar).

Discussion and Conclusions

These early results support NIRS imaging as a clinically relevant adjunct to standard vascular assessments. By delivering point-of-care perfusion insights directly at the wound bed, NIRS may help overcome limitations of traditional tools—particularly in patients with non-compressible vessels. While limited by single-site enrollment, this study highlights NIRS's promise as a scalable, accessible technology with potential to enhance decision-making and equity in wound care delivery.

1. Sen, C. K. Human Wound and Its Burden: Updated 2022 Compendium of Estimates. *Adv Wound Care* (New Rochelle) 12, 657–670 (2023).
 2. Schreml, S. et al. Oxygen in acute and chronic wound healing. *Br J Dermatol* 163, 257–268 (2010).
 3. Castilla, D. M., Liu, Z.-J. & Velazquez, O. C. Oxygen: Implications for Wound Healing. *Adv Wound Care* (New Rochelle) 1, 225–230 (2012).
 4. Oropallo, A. et al. Advancing chronic wound care with near-infrared spectroscopy imaging: clinical applications, measurement parameters, and insights into healing dynamics. *Wounds* 37, 384–392 (2025).
 5. Aerden, D. et al. The ankle-brachial index and the diabetic foot: a troublesome marriage. *Ann Vasc Surg* 25, 770–777 (2011).