Evaluating a Biomimetic Matrix for Chronic Wound Healing with Multispectral Imaging and Thermography: A Case Series

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Introduction

Chronic wounds, which affect millions globally, substantially reduce the patients' quality of life and place significant burdens on healthcare systems (Harding & Queen, 2012; Nussbaum et al. , 2018); Ebot, J., 2023). Effective management of chronic lower extremity wounds requires strategies that enhance tissue regrowth and revascularization (Arnold, 2018).

Imaging technologies have evolved significantly over the past 50 years, becoming a staple of everyday life. This explosion is the most significant in the so-called selfie. However, there are many areas within medicine where imaging is vital today for both diagnosis and the recording of many conditions, injuries and diseases. From the simple visualisation of a broken bone to the detection of cancer imaging has changed the practice of medicine. Seeing inside the body has improved the way in which patients are managed and often saves limbs and lives. Medical imaging offers clinicians quicker and more reliable diagnostic information Queen & Harding, 2020); Mamone et al, 2020).

Imaging guides clinicians in surgery for improved precision and accuracy, permitting them to assess disease progression or severity of an injury. This information helps choose the right approach and treatments. Imaging also allows a higher degree of assessment with regards to therapeutic efficacy of topical products used on wounds.

This study evaluates the performance of a polypeptide biomimetic matrix (BMM) designed to support chronic wound healing via an extracellular matrix-like scaffold and antibacterial protection, using multispectral near-infrared spectroscopy (NIRS) imaging. This will provide better insight to the therapeutic response.

Methods

Five patients with multiple comorbidities presenting chronic wounds that failed to respond to previous treatments - diabetic foot ulcers, pressure ulcers, venous leg ulcers - were treated with an FDA-approved flowable BMM (G4Derm™ Plus, Gel4Med).

G4Derm™ Plus is a novel flowable biomimetic matrix derived from Gel4Med's SMP™ technology to manage complex wounds.

G4Derm™ Plus system includes a pre-filled syringe and a flexible applicator tip that enables precise delivery of the flowable biomimetic matrix to irregularly shaped and hard-to-access wounds. G4Derm™ Plus forms a 3D scaffold that mimics the human extracellular matrix (ECM) and serves as an antibacterial barrier that protects the wound. The biomimetic matrix is uniquely positioned to simultaneously spur tissue regrowth and control bioburden.

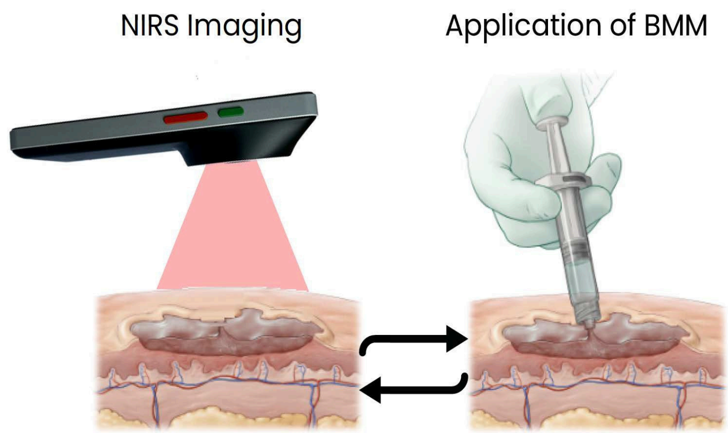


Figure 1 - Imaging and application

Multispectral NIRS, infrared (IR) thermal, and digital imaging were captured using a handheld mobile device (MIMOSA Pro, MIMOSA Diagnostics). The MIMOSA Pro captures tissue oximetry, temperature, and a digital image in seconds. The images are then relayed to a secure web portal where clinicians can identify early opportunities for intervention, track patient progress, and collaborate with other clinicians towards improved patient outcomes. This pocket-sized device can be used by any healthcare professional to collect and collate data for clinician review – allowing for a reduction in workload for the clinician and unprecedented access to care for patients. Tissue oxygen saturation (StO_2) was assessed at baseline and continuously monitored during following visits.

Results

All patients responded positively to BMM treatment, showing ischemic area defined as StO_2 <39% reduction and wound healing progression. Complete closure was achieved in all cases. In all five cases, an increase in tissue oxygenation was observed with BMM treatment and predicted healing, suggesting healthy tissue regrowth and revascularization, which ultimately resulted in complete wound closure.

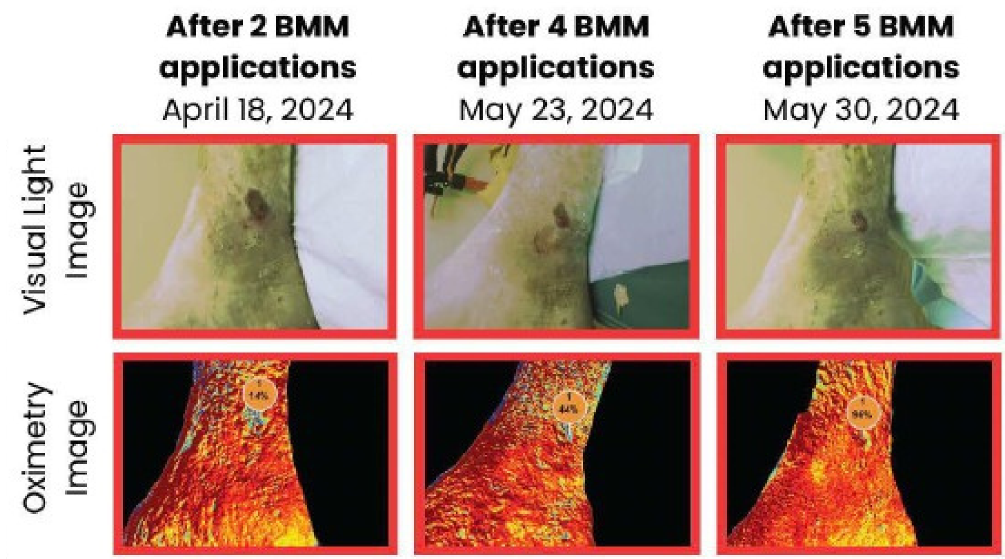
Clinical Characteristics of Study Participants

Case	Wound	Comorbities	Previous Interventions	Wound Age at Baseline	Group
1	Venous leg ulcer, right foot	Diabetes, KTS, PWS, PVD	SOC	5 Months	rapid
2	Pressure ulcer on back of leg	ALPS	Muscle flap, SOC	8 weeks	rapid
3	Venous leg ulcer, right ankle	Pre-diabetes, L, PVD	TMA, LER, TCC, SOC	6 months	slower
4	Venous leg ulcer (Right)	PVD	SOC	6 months	slower
5	DFU on transmetatarsal amputation (Right)	Diabetes	Bilateral TMA, SOC	8 months	depth

Comorbidities: ALPS - Autoimmune Lymphoproliferative Syndrome; KTS - Kippel-Trenaunay Syndrome; PWS - Parkes-Webber Syndrome; PVD - Peripheral Vascular Disease; L - Lymphedema.
Previous Interventions: SOC - Standard of Care

Case 1

- Venous Leg Ulcer Right Lateral Foot Patient was followed up using MIMOSA from April 18, 2024 to September 19, 2024
- The patient is an 85-year-old woman with a history of diabetes, Klippel-Trenaunay Syndrome, Parkes Weber Syndrome, multiple back surgeries, difficulty walking, lymphedema, and peripheral vascular disease (PVD).
- She also has a history of a hip fracture and significant venous disease, with adequate blood flow to the toes indicated by a satisfactory TBI.
- The wound measures 3 by 2 by 0.2 cm
- On May 23, 2024, after four applications, clinician commented, “The patient looks great. Look how small it is.” The wound had reduced in size significantly. The patient has Madison lymphedema, which required careful monitoring and treatment.

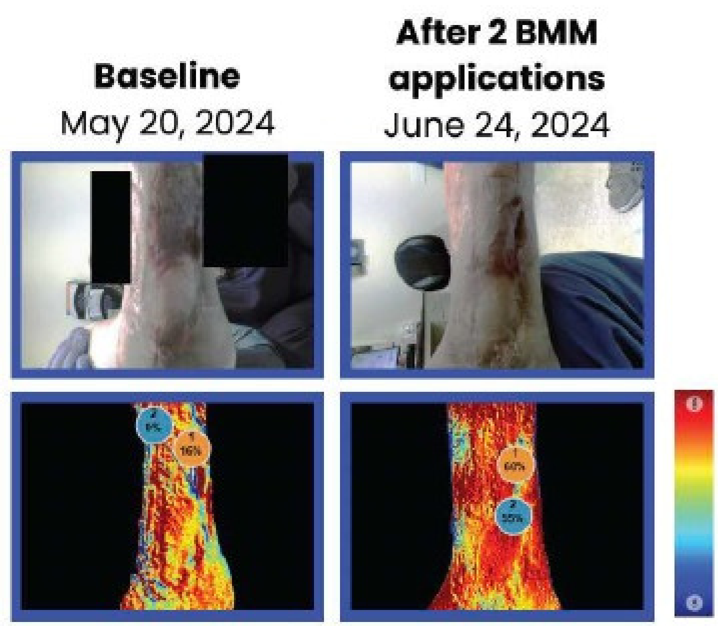


StO_2 -14% StO_2 -44% StO_2 -94%

Figure 2 - Case 1 chronology and results

Case 2

- On June 3, 2024, a paraplegic patient with Alps syndrome since birth presented with a recurrent pressure wound on the back side, located at the site of a previous muscle flap.
- The wound measured 2.9 × 0.9 × 0.3 cm at presentation, despite prior treatment attempts.
- The patient was followed from May 6, 2024, to September 19, 2024 (using MIMOSA Pro).
- Before the first application, no improvement was observed with standard of care (SOC) alone.
- By July 1, 2024, after three applications, the clinician noted, "The patient looks so good," reflecting visible clinical improvement.
- Complete closure was achieved within six weeks following treatment initiation.



StO_2 16% & StO_2 0% StO_2 60% & StO_2 55%

Figure 3 - Case 2 chronology and results

Case 3

- The patient was followed from April 16, 2024, to April 22, 2025 (using MIMOSA Pro)
- No improvement with SOC. Partial closure after 9 BMM applications
- Partial wound closure was noted with bottom-up recovery.
- The patient has significant comorbidities affecting healing, including venous disease, lymphedema, peripheral vascular disease (PVD), a fused ankle, multiple surgeries, difficulty walking (uses a walker), and severe back problems. He is also prediabetic.
- The patient is retired and takes care of his wife

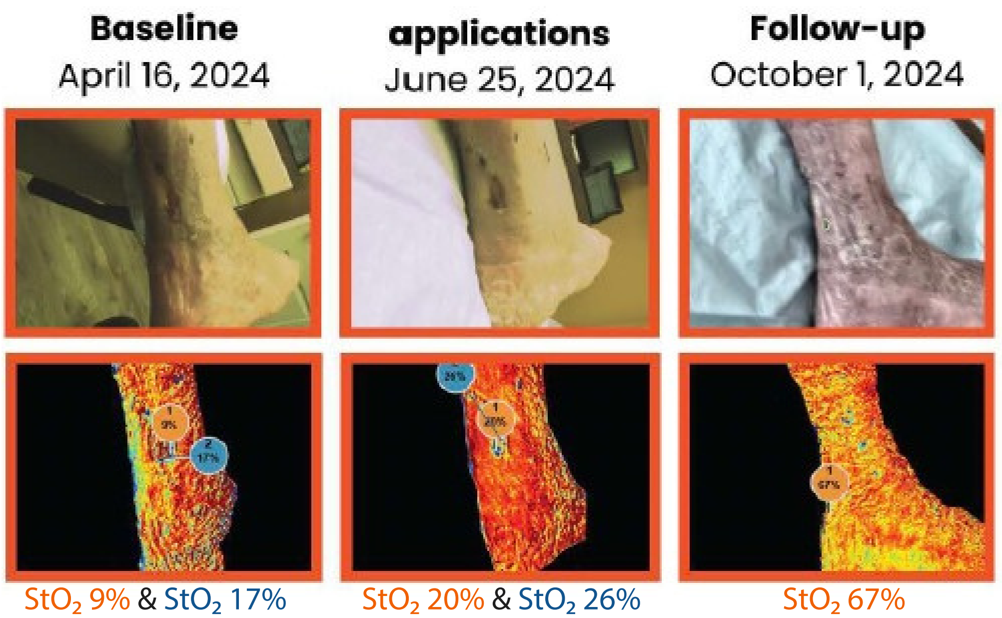
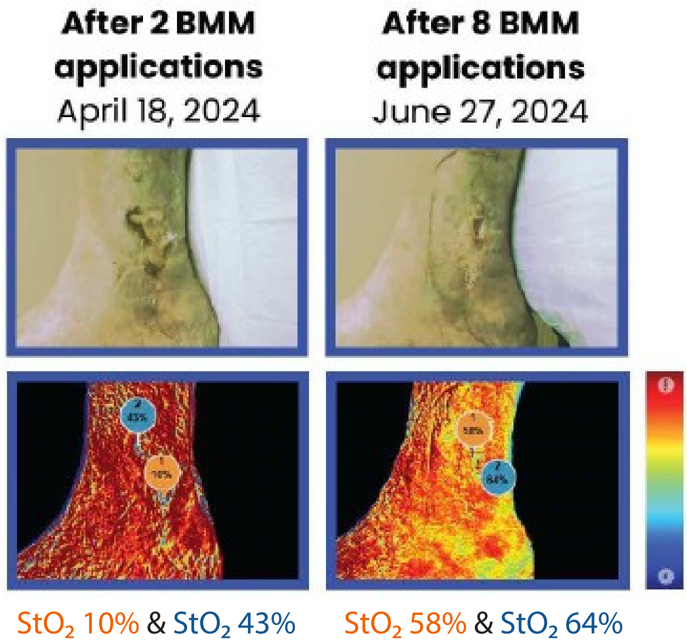


Figure 4 - Case 3 chronology and results

Case 4

- The patient was followed from April 18, 2024, to April 3, 2025 (using MIMOSA Pro) Venous Leg Ulcer (Right Medial Ankle)
- Partially closed after 12 applications
- The patient has a history of bad venous disease with a 30-year history of recurrent ulcerations and bad reflux. Although not diabetic, the patient is obese and has a TBI of 0.9.
- They have had a Venous Leg Ulcer (VLU) for 3-4 months before treatment, initially measuring 4 x 3 x 0.2 cm March 21, 2024.
- Due to job requirements, the patient keeps their leg dependent, leading to significant lichenification secondary to venous weeping.
- The wound has shown approximately 30-40% reduction in size since the start of treatment (by August 08, 2024).
- The skin around the wound is hard and fibrotic, with fibrinous and sclerotic tissue, which lacks elasticity and may require debridement due to potential calcification.
- There is a little bit of drainage that needs to be managed due to inflammation.

Figure 5 - Case 4 chronology and results



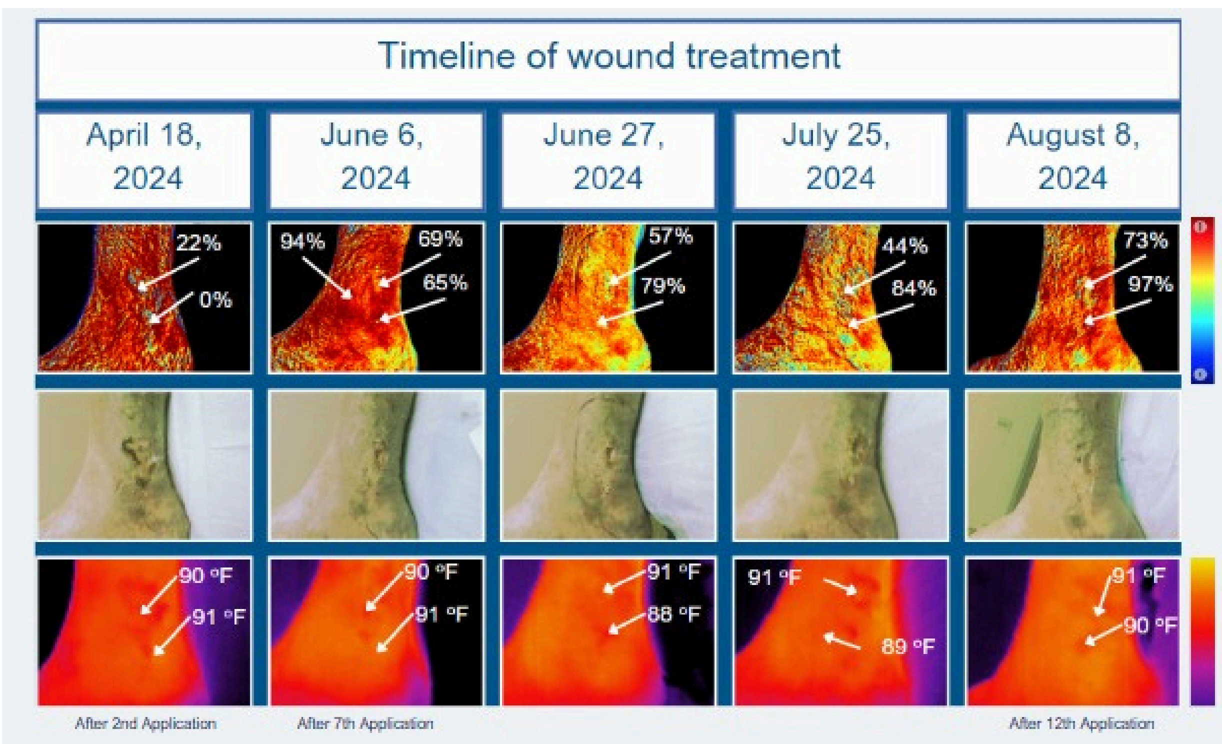


Figure 6 - Case 4 chronology

Case 5

- The patient was followed from April 16, 2024, to April 11, 2025 (using MIMOSA Pro). DFU on Transmetatarsal amputation (Right)
- During the initial follow-up period (May 28, 2024 – Day 0, to August 6, 2024 – after the 8th application), clinical observations indicated clear wound improvement. Although the wound had not fully closed, it was progressing along a healing trajectory.
- By September 24, 2024, the wound area was measured at 1.4 cm^2.
- According to data from the MIMOSA web portal, it reduced to 0.7 cm^2 by October 1 and remained stable on October 8—demonstrating continued healing.
- No wound re-opening after initial closure (up to now)

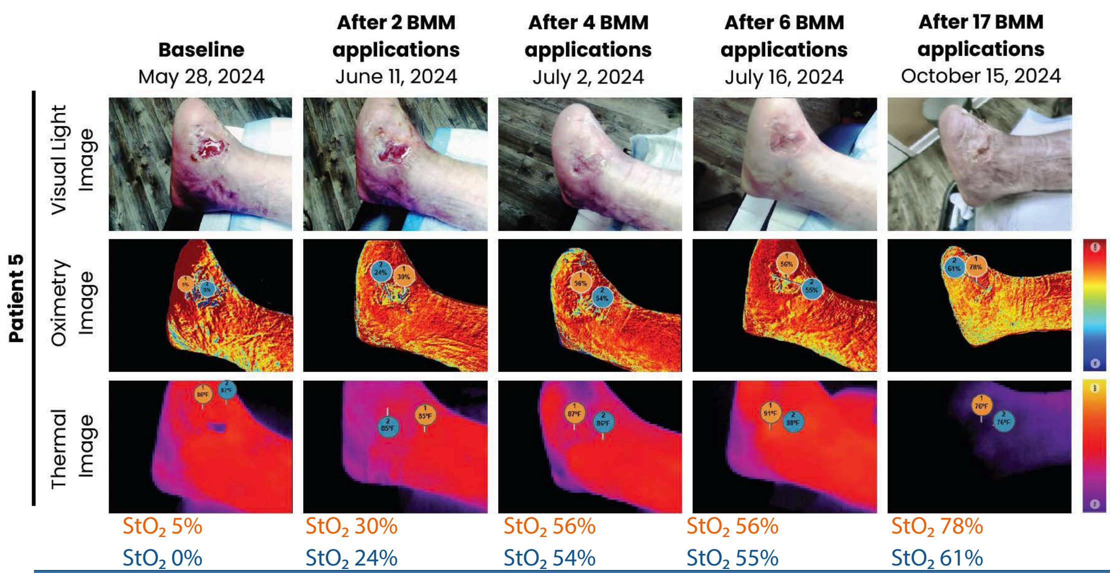


Figure 7 - Case 5 results

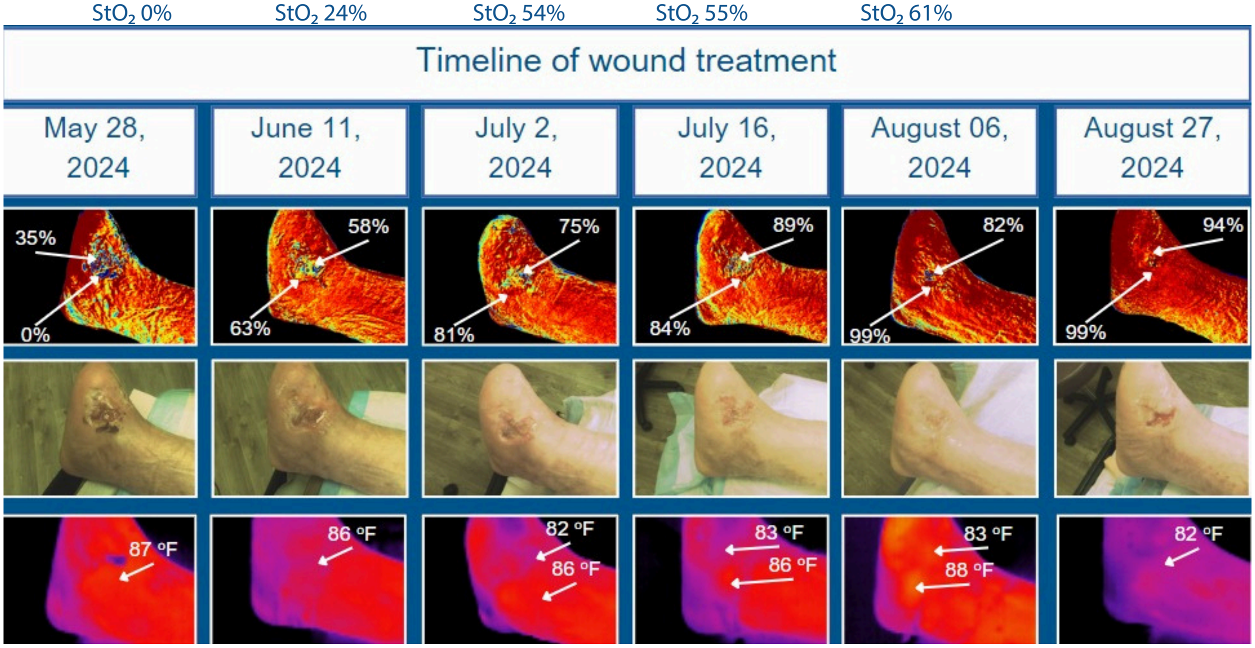


Figure 8 - Case 5 chronology

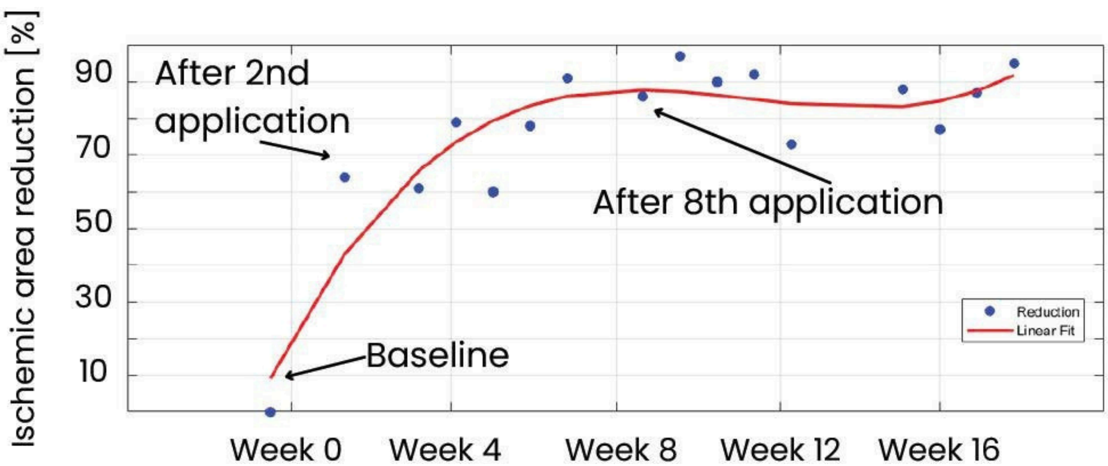


Figure 9 ischemic area reduction over time.

Discussion

Current wound assessment is difficult and multifactorial. Many of the technologies used for assessment have limitations leading to inaccuracy in wound assessment. Clinicians require fast easy to use technologies to aid with the assessment for all despite experience. These need to be real-time providing an indication of tissue health status with easy standardised interpretation of results, both good and bad. Such tools would help immensely by decreasing financial burden on the health care system by eliminating the need to cycle through varied protocols of treatments through trial and error.

The past few decades have shown significant strides in the improvement of wound assessment and treatment. However, technological tools to aid with this have been slow to evolve. Many existing clinical tools have been modified to work within wound care, but most have limitations making them somewhat inappropriate for this clinical area. The main limitations for most of these technologies center around high cost and low specificity.

Current and emerging imaging technologies offer a deeper insight into both the wound and its underlying physiology.

By visualising and obtaining this deeper insight the knowledge provided offers higher clinical relevance of the assessment. While being in the early stages of implementation within wound care many have gained experience and relevance in other clinical and non- clinical areas. The major benefit for wound care is as they become more and more integrated into wound care practice, they are fast becoming part of routine clinical workflow. This is especially true of the more portable and easier to use devices. While the interpretation of diagnostic output maybe be more complex this is often simplified via artificial intelligence and machine learning to present a diagnostic output.

The use of new diagnostic imaging technologies has started to change the clinical management of all types of wounds.

Specifically, it has improved both the assessment and management of wounds and provides visual documentation that enhances patient engagement and facilitates better treatment compliance. Newer approaches address limitations by bringing imaging approaches with speed, precision, real-time responsiveness, portability, and smartphone capability. This opens the wound care diagnostic field by providing more efficient and easily understood assessment in real-time, helping clinicians help their patients.

This case series highlights the potential of BMM in treating hard-to-heal wounds, unresponsive to SOC, by fostering an environment that promotes tissue regrowth and neovascularization. NIRS imaging provided an objective, non-invasive measure of oxygenation, helpful in predicting ulcer healing trajectory and treatment effectiveness. The reduction in ischemic area emerged as a potential marker for assessing tissue regeneration and revascularization.

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