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Conventional podiatric intervention and phototherapy in the treatment of diabetic ulcers



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ARTICLE INFO

ABSTRACT

Contemporary podiatry care involves a dynamic management plan to treat type 2 diabetes mellitus lower-limb ulcerations. Phototherapy is a noninvasive form of light therapy that has been shown to accelerate the healing rate of diabetic ulcers. This study aimed to establish whether the application of phototherapy combined with podiatric treatment improved the rate of wound healing of chronic diabetes mellitus foot ulcers. Patients with type 2 diabetes mellitus presenting with chronic lower-limb ulcers were divided into three groups: group 1 were treated with podiatric management and placebo phototherapy; group 2 were treated similarly, but with the addition of phototherapy on the ulcer(s); and group 3 were treated similarly but phototherapy was applied to the regional lymphatic nodes and ulcer(s). The rate of healing increased in all three groups, however, in this study, 67% of ulcers that were managed received some form of phototherapeutic intervention and 40% of those ulcers resolved completely in a period of <8 weeks with no adverse effects being reported by any of the participants. It is evident that a combination of conventional podiatric intervention and phototherapy has the ability to improve wound regeneration and decrease the level of secondary complications.

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1. Introduction

Diabetes mellitus (DM) has become a global burden, with 382 million cases and 46% undiagnosed cases worldwide in 2013 [1]. These numbers are on the rise, and countries, including South Africa, are struggling to keep up with the disease and management of its complications. The majority of patients are between the ages of 40 and 59 years, and approximately 80% live in low- and middle-income countries. The International Diabetes Federation diabetes atlas offers a concerning indication of the impact of DM as a major threat to global development [1]. DM ulcers are one of the most problematic,

debilitating, and common issue occurring in patients with type 2 DM. Lower-limb complications in DM constitute a challenge for patients, podiatrists, and other health care professionals [2]. DM foot ulcerations are one of the most costly complications, accounting for 50% of all nontraumatic amputations [3,4]. Foot ulcers heal particularly slowly and have an impact on the patient's quality of life, requiring intensive long-term treatment [5]. The quality of life for a patient with DM suffering from foot ulcers is comparable with that of a patient with breast cancer [5,6]. Therefore, there is a need for researchers to generate new treatment modalities to improve the healing rate and outcomes of DM wounds [7].

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Current podiatric protocols for the management of chronic lower-limb ulcers include mechanical debridement, antibiotics, alterations of footwear, and mechanical off-loading and regular visits to the foot clinic. With continuous management, ongoing surveillance, and monitoring, this can result in an increase in quality of life, physical activity, and eventually patient levels of compliance.

Phototherapy is a noninvasive treatment that uses light of a specific wavelength to treat a variety of medical conditions, including wounds. Photon energy is absorbed by photoacceptor molecules. The photoacceptor is excited and stimulates cellular metabolism by activating or deactivating enzymes, which alter other macromolecules [8–12]. This then gives rise to observable effects at a biologic level [8,13]. Devices used in phototherapy typically emit no heat, sound, or vibration, and there is no immediate increase in temperature post irradiation, unlike that which is seen in high-energy lasers used in surgery [14,15]. Al-Watban [16] irradiated full-thickness or burn wounds in rats with diabetes and suggested that phototherapy with 633 nm should be given three times per week at a fluence of 2.35 J/cm² per dose for wounds, or 4.71 J/cm² for burn wounds. Various other studies done on rats or mice have shown an increase in collagen production, decrease in inflammatory cells, decrease in oxidative stress, improved muscle repair, and increased epithelialization and granulation [17–20]. Peplow and colleagues [21] showed that the effects are due to cellular and biochemical changes in the wound environment rather than a hypoglycemic effect. Schindl et al [22] noted that this treatment modality might constitute a side effect–free route for healing neuropathic ulcers in patients with diabetes. Minatel and colleagues [23] showed that phototherapy promotes tissue granulation and rapid healing along with some pain relief for patients with foot ulcers that failed to respond to other methods of treatment. Kaviani et al [24], irradiated foot ulcers at 685 nm with 10 J/cm² and demonstrated that phototherapy significantly diminished the size of these ulcers, with a mean healing time of 11 weeks compared with 14 weeks, as observed in the placebo group.

The application of phototherapy in wound care may enhance the treatment and healing time, with a goal of complete recovery [25]. Although it would be ignorant to undermine the benefit of a multidisciplinary approach in the treatment of such foot ulcers, phototherapy needs to be adequately evaluated within a clinical environment in order for the possible benefits to be recognized. This study aimed to determine whether participants with diabetes with chronic lower-limb ulcers responded better to the combined treatment of podiatric intervention and phototherapy, as well as to determine whether phototherapy of the lymphatic nodes and the ulcer was a better treatment option than just phototherapy of the ulcer alone.

2. Materials and methods

The study protocol was registered with the Pan African Clinical Trial Registry (PACTR201203000367225) and approved by the Faculty Academic Ethics Committee (AEC72/01-2011). Written informed consent was obtained from participants. The project was a single-blinded, prospective experimental pilot study.

2.1. Subjects

Seven adult patients with 15 lower-extremity ulcers diagnosed with type 2 diabetes were recruited from the University of Johannesburg Podiatry Clinic and the Charlotte Maxeke Academic Johannesburg Hospital. The following inclusion and exclusion criteria were used.²³ Inclusion criteria were type 2 diabetes with neuropathic or mixed (venous and arterial) ulcers; lower extremity ulcer; stable or worsening ulcer that has been present for a minimum of 4 weeks; willingness to participate in and commitment to the study; and signed consent to participate in the study. Exclusion criteria were evidence of acute cellulitis, osteomyelitis, or gangrene; presence of any of one or more medical conditions including renal, hepatic, hematologic, neurologic, or immune disease not related to diabetes; presence of malignant disease (other than basal cell carcinoma) not in remission for more than 5 years; use of oral or parenteral corticosteroids, immunosuppressive, or cytotoxic agents; known infection with human immunodeficiency virus or presence of AIDS; use of other investigational drug or device within 30 days of recruitment into the study; and other leg ulcers, such as ulcers due to decubiti or vasculitis.

Participants that meet all prerequisites of the inclusion criteria entered the study and were divided into three groups: group 1, which was the control group and received placebo phototherapy and standard podiatric treatment; group 2, which received phototherapy of the ulcer and standard podiatric treatment; and group 3, which received phototherapy of the ulcer and lymph nodes and standard podiatric treatment.

2.2. Podiatric treatment

Podiatric treatments for DM ulcers are dynamic and depend on the type of ulcer as well as its location. The main forms of treatment in the University of Johannesburg Podiatry clinic are as follows:

- Cleaning and debridement: If the ulcer presented with a red healing base, 0.9% physiologic saline was used to irrigate the lesion. If the ulcer presented with slough then the use of enzymatic wound debridement using Irujol mono-ointment was utilized. Mechanical debridement was done using a surgical blade and handle.
- Wound dressing and management: Ulcers were dressed with Silbecor 1% along with gauze and Primapore.
- Rest and off-loading: This was achieved by active bed rest, aircast boots, temporary semi-compressed pads, shoe innersoles, accommodative orthotics, and an alteration of footwear.
- Infection: A combination of topical, oral, and intravenous antibiotics was used when necessary.

2.3. Phototherapy

Ulcers were treated with the Photizo Physiotherapist642 unit (Photon Therapy Systems (Pty) Ltd, Kosmosdal, Samrand, South Africa) after podiatric treatment and before wound dressing. Participants in group 1 received placebo phototherapy. This was

achieved by the probe cable being disconnected (but held in place by tape) at the back of the phototherapy unit, so no light exited the probe. Participants were unaware whether light was coming through or not because the safety goggles filtered out the visible light. Ulcers of participants in groups 2 and 3 received phototherapy. In addition, participants in group 3 received phototherapy of the regional lymph nodes; this was to increase drainage of the area. Patients were treated twice a week (72 hours between treatments) until the ulcer healed, or for a maximum of 90 days.

The 1,200-mW cluster probe used with the Photizo Physiotherapist642 unit has three 630-nm light-emitting diodes (LEDs; visible red light; total power output 405 mW) and eight 850-nm LEDs (infrared light; total power output 800 mW). The diameter of the cluster head was 46 mm, and the beam spot size was 16 cm² (power density of 75 mW/cm²). The pulsed to continuous ratio of the light delivered is 30% to 70%, respectively. The instrument is preprogrammed, and to treat ulcers, the “wounds” protocol was chosen (292,930,1174,1520,1574,1604,4788,6352 Hz). This delivered a total energy of 3 J/cm² per spot, which took approximately 51 seconds. The probe was covered with clear, sterile plastic to prevent cross-contamination. The covered probe was pressed lightly onto the ulcer (contact mode) and sequentially one spot at a time was treated until the entire ulcer was treated. The number of spots that were treated depended on the size of the ulcer. The edges of the ulcer were treated first and then the center. To irradiate the lymph nodes, the “muscular” protocol was chosen (292,588,1520,1604,1756,1760,9396 Hz). This also delivered a total energy of 3 J/cm² (68 seconds). Lymph nodes in the groin and behind the knee of the affected limb were treated. This was performed before irradiation of the ulcer(s).

2.4. Data analysis

Ulcers were examined visually and by digital photography. Photographs were taken before and after each treatment session. The camera was set at a fixed height (on a tripod) and distance (30 cm) from the ulcer to ensure standard photography. The size of the ulcer and area of granulation were measured using Image J software (US National Institute of Health, Bethesda, MD) [23]. In this analysis, the edge of the ulcer was delineated and then the software computed the area of the ulcer. The area was then ratioed to the scale of the metric ruler, and the area of granulation calculated using the threshold color [23].

3. Results

Seven participants, all with a history of type 2 DM, with a total of 14 chronic lower-limb ulcerations participated. Participant demographics are demonstrated in Table 1. Participants were randomly assigned within one of the three groups. All participants were taking medication to manage the condition, and most participants had other comorbidities, which were being adequately managed.

3.1. Group 1: placebo group

3.1.1. Case 1

A 52-year-old male presenting with three chronic lower-limb ulcerations. Peripheral neuropathy was evident in the dependent limb with minimal signs of vasculopathy. The patient presented with a below-knee amputation of the left

Table 1 – Demographic characteristics of study participants.

Case no.	Race	Age (years)	Sex	Mobility	No. of years diagnosed with type 2 diabetes	Ulcers (n)	Etiology	Other conditions ^a
1	African	52	Male	Crutches	20	3	Peripheral neuropathy and excessive pedal pressure	Hypertension; hyperlipidemia
2	African	79	Male	Mobile	7	1	Peripheral neuropathy, excessive pedal pressure and previous trauma	Hypertension
3	Caucasian	72	Male	Mobile	20	1	Self-inflicted trauma, peripheral neuropathy, and excessive pedal pressure	Hypertension; gout; heart disease
4	Indian	55	Male	Mobile	15	1	Peripheral neuropathy, excessive pedal pressure, and tinea pedis	Hypertension; claustrophobia
5	Caucasian	55	Male	Mobile	15	1	Venous insufficiency	Hypertension
6	African	53	Female	Crutch	20	1	Bed rest, peripheral neuropathy, incorrect footwear and excessive pedal pressure	Hypertension; hyperlipidemia; rheumatoid arthritis
7	Coloured	67	Male	Mobile	20	6	Peripheral neuropathy, vascular impairment, and excessive pedal pressure	Hypertension; pneumonia

In South Africa, the term “Coloured” is an ethnic label for people of mixed ethnic origin who possess ancestry from Europe, Asia, and various Khoisan and Bantu ethnic groups of southern Africa.

^aAll conditions were being treated accordingly by the participant’s relevant practitioner.

lower limb. The patient reported that the first ulceration, on the plantar aspect of the foot, commenced 12 months before participating in the study. All three ulcers were classified as arterial ulcerations. The stump presented with two ulcers that were located along the surgical scar tissue; during the fourth week of treatment the patient injured the stump after falling over. Wound irrigation, offloading, and mechanical debridement were implemented. With treatment, the ulcer perimeter and area decreased gradually (Fig. 1A). Granulation tissue was visible in all three ulcers after 2 weeks, however, the presence of slough and tissue debris within the ulcer beds were noticed, which complicated matters (Fig. 1B). On completion of the treatment period, the ulcer located on the plantar aspect of the foot reduced by approximately 93%. The ulcer located on the medial aspect of the stump resolved by 100% (Fig. 1C). An infection in the lateral ulcer of the stump

(treated with a 7-day course of oral antibiotics) occurred during the seventh week of treatment, with an overall resolution of only 10% by the end of the study. The remaining ulcers displayed no signs of secondary complications. Although the participant reported no pain or side effects, he noticed that, with continuous intervention, the levels of phantom-limb phenomenon increased.

3.1.2. Case 2

A 79-year-old male presented with a single ulcer on the medial malleolus of the right lower limb. The ulceration developed 24 months before participating in the study. The patient highlighted a strange discomfort originating in the proximity of the right lower leg localized around the surrounding ulcer tissue, with no signs or symptoms of infection. At 2 weeks, ulcer size had reduced and granulation

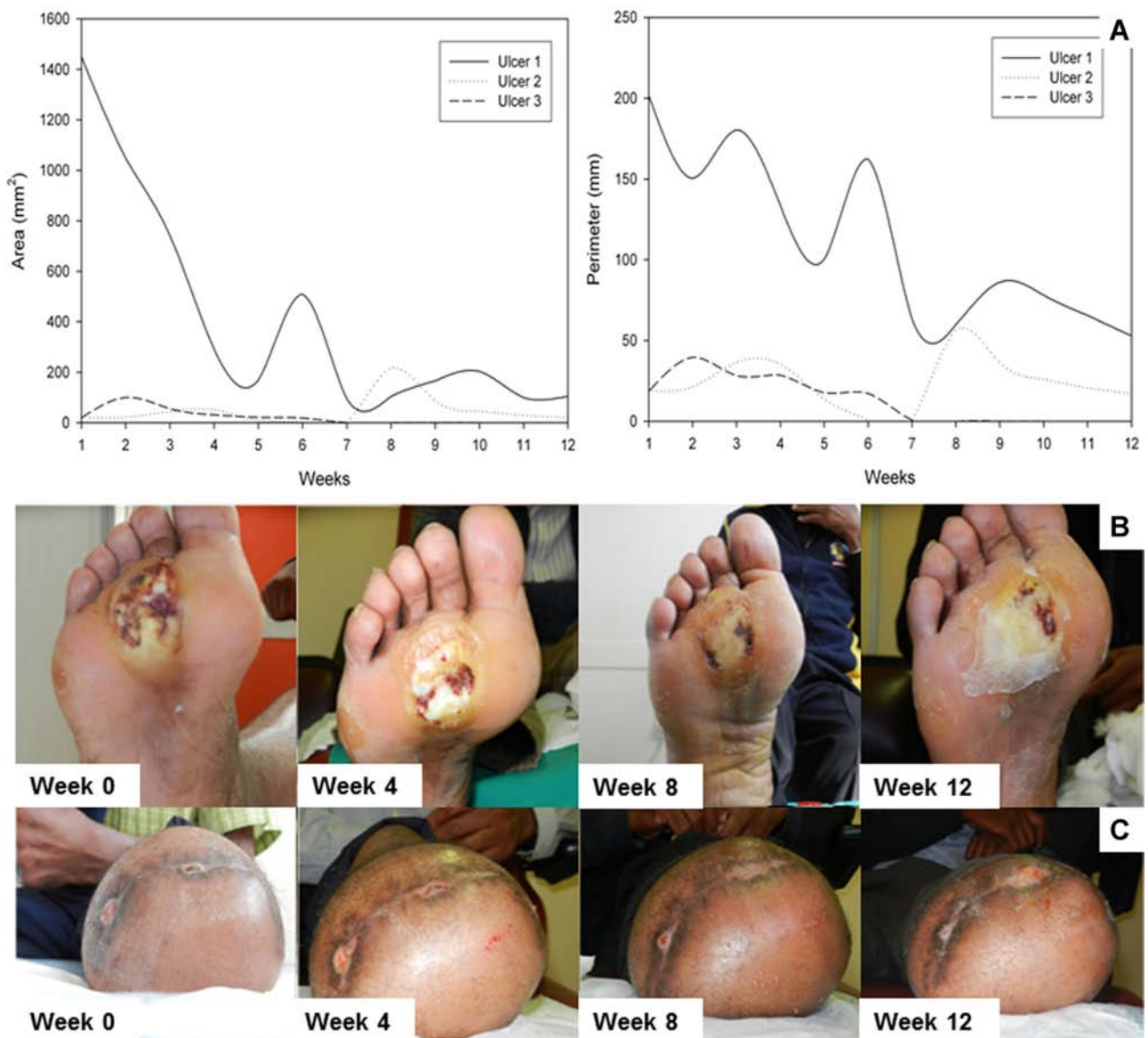


Fig. 1 – Case 1. A 52-year-old African male with three ulcers. The ulcers were treated weekly for 12 weeks with standard podiatric treatment and sham laser irradiation. The area (mm²) and perimeter (mm) of the ulcers was measured (A). Ulcer 1 was located on plantar aspect of the right foot (B) and ulcer 2 and 3 were located along the scar tissue of the left stump (C). At week 12, there was a considerable reduction in all ulcer sizes.

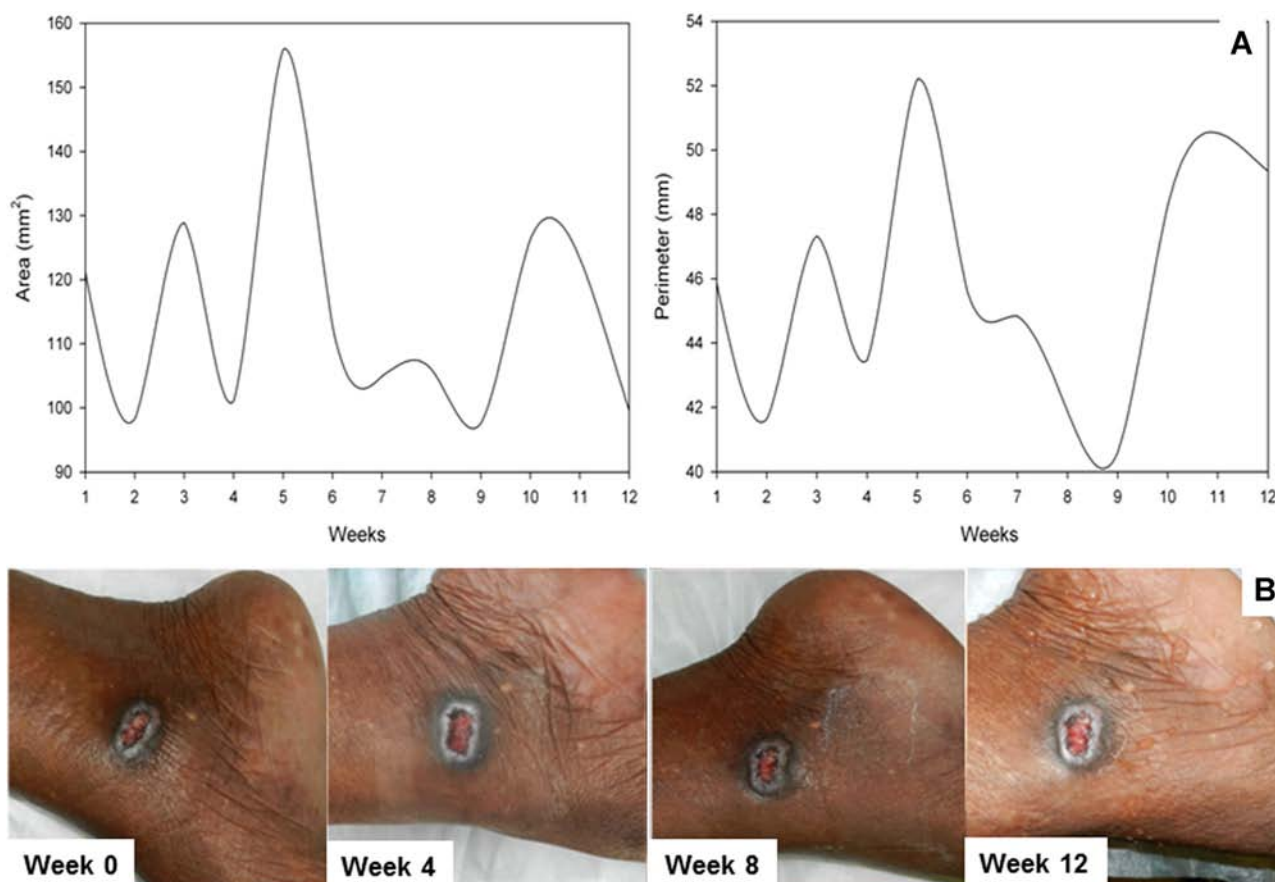


Fig. 2 – Case 2. A 79-year-old African male with an ulcer on the medial malleolus of the right foot. The ulcer was treated weekly for 12 weeks with standard podiatric treatment and sham laser irradiation. The area (mm²) and perimeter (mm) of the ulcer was measured (A). At the week 12, there was an 18% reduction in ulcer area size (B).

tissue was evident. Regression was apparent at weeks 3, 5, and 10, which surpassed the initial size of the ulcer. Healing improved in week 11 and the final week (Fig. 2A and 2B). On completion of the treatments, the ulcer had attained an overall resolution of 18%. The participant reported no adverse side effects.

3.2. Group 2: phototherapy of the ulcer

3.2.1. Case 3

The participant was a 72-year-old male with one chronic ulcer on the plantar aspect of the foot. Peripheral neuropathy was evident in both limbs with minimal signs of vasculopathy. The patient reported that ulceration commenced 48 months before participating; he reported injuring himself while attempting to remove “hard” skin. The ulcer presented with no signs or symptoms of infection. At 2 weeks, the size of the ulcer had reduced and granulation tissue was evident. Regression was apparent at weeks 4, 7, and 10, and did not surpass the initial size of the ulcer. Regression involved an increase in the area as well as the perimeter of the ulcer and was thought to be as a result of mechanical debridement. On completion of treatment, the ulcer had attained an overall resolution of 38% (Fig. 3A and 3B). The participant reported an unusual “pricking” sensation within the ulcer during week 5

of treatment. At week 7, he noted that he was able to feel the sterile gauze used to swab the ulcer bed, it was described as an “uncomfortable” sensation because he was initially unable to receive any light touch stimulus on commencement of the study due the presence of peripheral neuropathy.

3.2.2. Case 4

A 55-year-old male presented with one interdigitally chronic ulcer. The participant was an excessive smoker and presented with a history of tinea pedis. Peripheral neuropathy was evident in both limbs with minimal signs of vasculopathy. The participant reported that the ulceration commenced 12 months before the start of the study. The ulcer was classified as a mixed ulcer that presented with no signs or symptoms of infection. The tinea pedis was managed utilizing a topical antifungal. At 2 weeks, the size of the ulcer had sufficiently reduced and granulation tissue was evident. At 3 weeks, the ulcer had completely resolved with no side effects detected by the participant (Fig. 4A and 4B). The participant reported that treatment positively affected his quality of life and that he was satisfied with the outcome.

3.2.3. Case 5

A 55-year-old male presenting with one chronic ulcer located on the lateral aspect of the lower leg. The participant

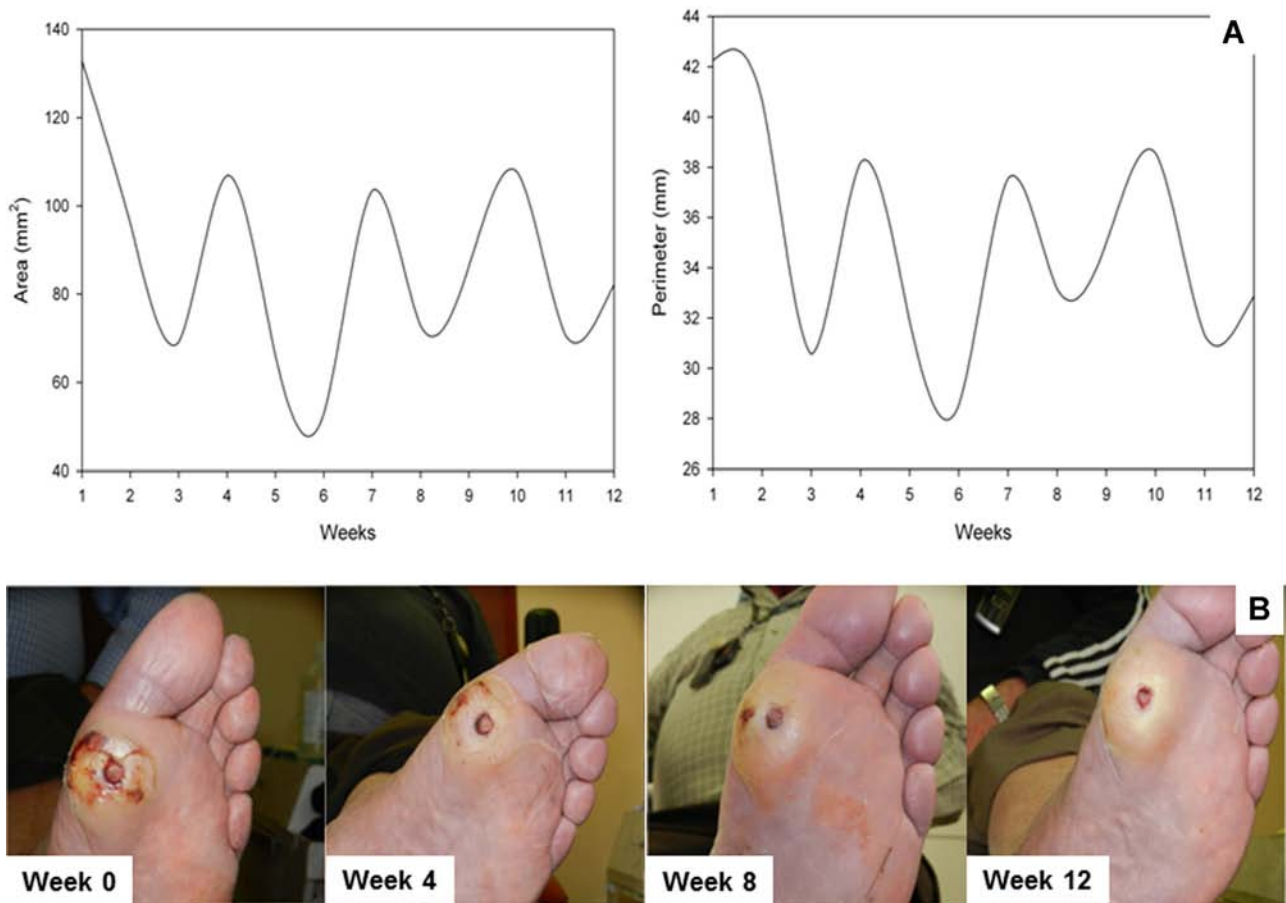


Fig. 3 – Case 3. A 72-year-old Caucasian male with an ulcer on the plantar aspect of the first metatarsal head. The ulcer was treated for 12 weeks with standard podiatric treatment and phototherapy. The area (mm²) and perimeter (mm) of the ulcer was measured (A). At week 12, there was a 38% reduction in ulcer size (B).

presented with varicose veins with signs of venous insufficiency and was using elastic stockings as a form of management; he had no signs of peripheral neuropathy and arterial insufficiency. The participant reported that the ulceration commenced 10 months before the start of the study. The ulcer was classified as a venous ulcer that presented with no signs or symptoms of infection. At 2 weeks, the size of the ulcer had sufficiently increased by approximately 34% (Fig. 5A). This was associated with occasional pedal edema and a “prickling” sensation involving the surrounding tissues. The participant reported that these sensations would commonly occur 1–2 days after irradiation. The formation of granulation tissue became evident during week 9, forming around the outer borders of the lesion. The edges of the lesion remained consistently raised and macerated due to the dressings that were being utilized (Fig. 5B). On completion of the treatment, the ulcer had attained an overall resolution of 26% (Fig. 5A and 5B). It was, however, noted that surrounding tissues had become significantly cyanosed and some hyperpigmentation was apparent in the surrounding skin as well. This was not associated with any pain or tenderness. Although complete resolution was not attained, the patient felt that the therapy had a positive overall effect on his condition and his quality of life.

3.3. Group 3: phototherapy of ulcer and regional lymph nodes

3.3.1. Case 6

A 53-year-old female presenting with one ulcer on the posterior aspect of the right calcaneus. The participant had a hip replacement of the right pelvis 9 months earlier and was on bed rest for 8 weeks. Peripheral neuropathy was evident in the both limbs with weak pedal pulses. It was reported that the ulceration commenced 3 months before participation. The ulcer presented with no signs or symptoms of infection. At 2 weeks, the size of the ulcer had decreased by approximately 39% (Fig. 6A). The participant noticed a significant reduction in the amount of associated discomfort. The formation of granulation tissue became evident in week 3, forming around the outer borders of the lesion. Hyperkeratosis around the edges of the ulcer required constant debridement; the edges of the lesion became flattened and macerated due to the dressings that were being utilized. Complete resolution was attained in 8 weeks (Fig. 6B). The participant reported no side effects and that treatment had a positive effect on her quality of life.

3.3.2. Case 7

A 67-year-old male presented with six chronic lower-limb ulcerations. All ulcerations involved the left foot and ankle.

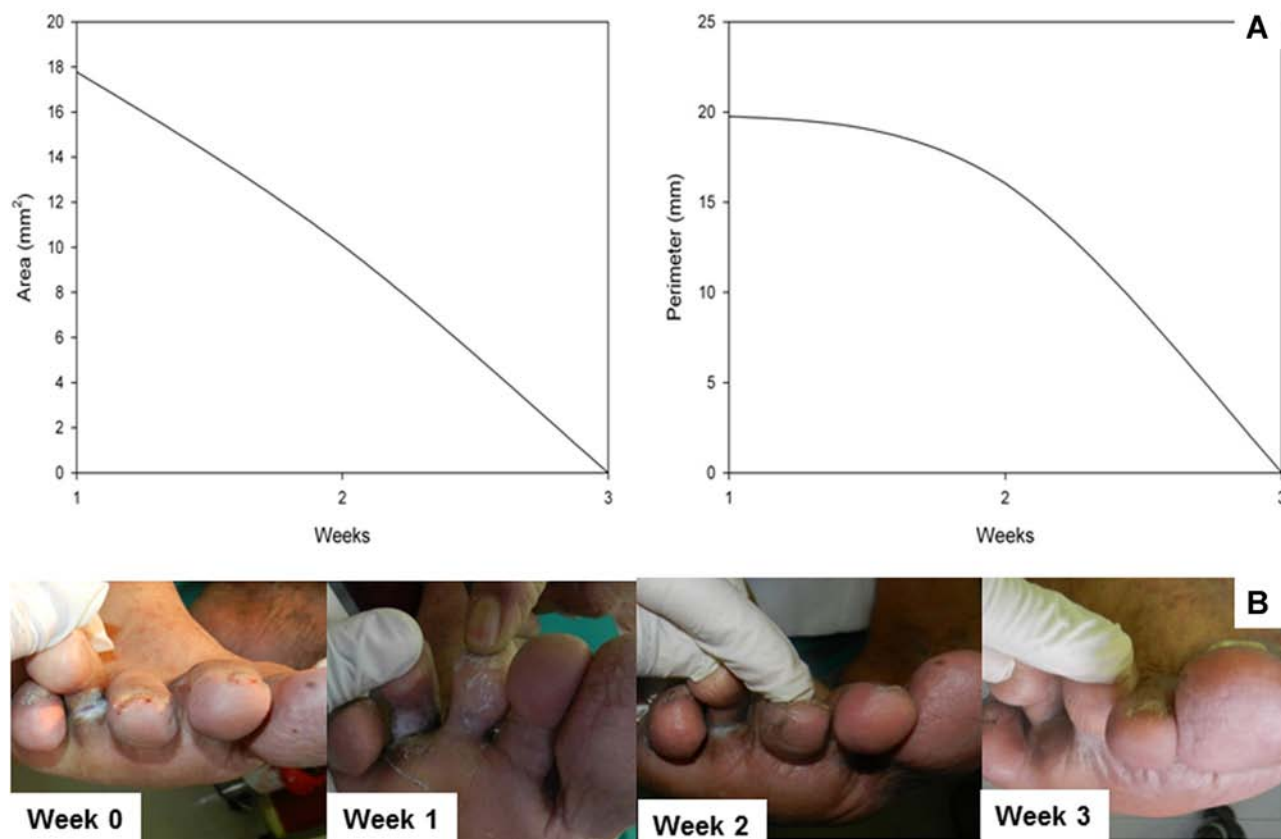


Fig. 4 – Case 4. A 55-year-old Indian male with an ulcer in the plantar-interdigital area of the third and fourth digit of the right foot. The ulcer was treated for 3 weeks with standard podiatric treatment and phototherapy. The area (mm²) and perimeter (mm) of the ulcer was measured (A). By week 3, the ulcer had resolved completely (B).

Ulcer 1 was located on the plantar-medial aspect of the first metatarsal head; ulcer 2 on the lateral aspect of the fifth metatarsal head; ulcer 3 on the medial-interdigital aspect of the fifth digit; ulcer 4 on the medial-interdigital aspect of the fourth digit; ulcer 5 on the dorsum of the third digit; and ulcer 6 was located on the anterior aspect of the ankle. Peripheral neuropathy was evident in both limbs associated with weak pedal pulses. The participant reported that ulcers commenced 36 months before participation. Ulcers were classified as neuroischemic and the foot was classified as “at risk.” The ulcer presented with no signs or symptoms of infection. Ulcer sizes appeared to fluctuate with treatment. Granulation tissue was visible in all six ulcers at 2 weeks, but was complicated, at times, by the presence of slough and tissue debris within the ulcer beds. The participant reported occasional sharp pains in the affected limb that occurred mostly at night and 1–2 days after treatment. Infection in week 4 was managed prophylactically with oral antibiotics for 7 days. On completion of the study, ulcer 1 had reduced by 30% and both ulcer 5 and ulcer 6 had resolved 100% and were observed carefully until week 9 (Fig. 7A and 7B). Ulcer 2 had increased significantly by 48% and was deeper, ulcer 3 had increased significantly by 45%, and ulcer 4 increased by 4% (Fig. 7A and 7B). The participant reported an increase in lower-limb discomfort. He described pain as occasional sharp pains that were felt mainly in the left lower limb. It was suspected that the participant’s general health status

and poor diabetes control was directly related to the poor outcome of treatment.

4. Discussion

The aim of this pilot study was to determine whether patients with diabetes with chronic lower-limb ulcerations responded better to a combined treatment of podiatric intervention and phototherapy, as well as to establish whether irradiation of the lymphatic nodes was a better treatment option than just irradiation of the ulcer alone.

Our results clearly demonstrate that a combination of podiatric management and phototherapy yields the potential to stimulate and increase healing rates of chronic ulcers due to diabetes. Healing rates increased in all three groups, however, in this study, 67% of ulcers that were treated received phototherapeutic intervention and 40% of those ulcers were completely resolved in a period of <8 weeks with no adverse effects being reported. It was further noted that one ulcer in group 2 (phototherapy of the ulcer) resolved in a period of <3 weeks, and the group had a mean healing rate of 55% over 12 weeks. Only 10% of ulcers managed with placebo phototherapy and podiatric interventions resolved completely. This clearly emphasizes the efficiency of phototherapy in combination with conventional podiatric management.

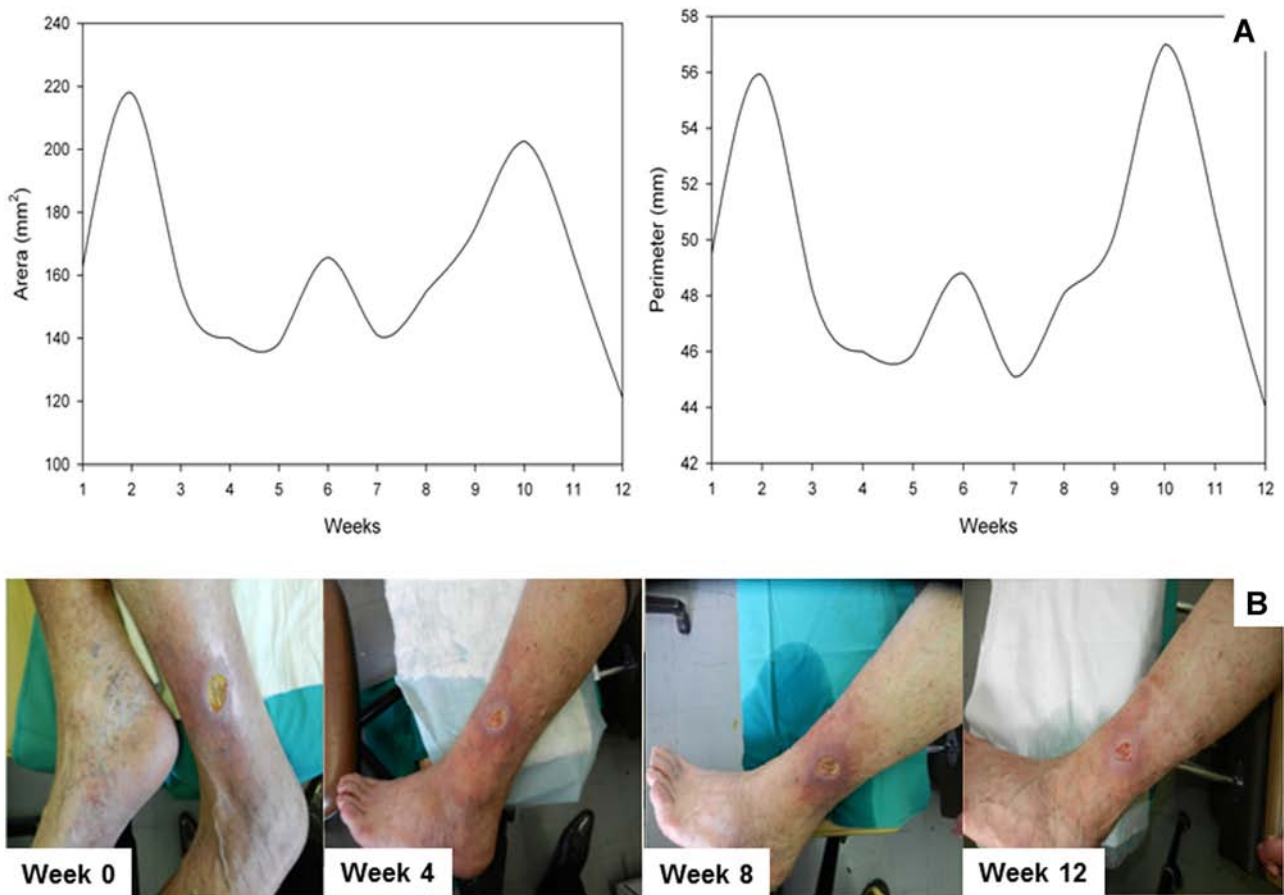


Fig. 5 – Case 5. A 55-year-old Caucasian male with a venous ulcer on the lateral aspect of the lower leg. The ulcer was treated for 12 weeks with standard podiatric treatment and phototherapy. The area (mm²) and perimeter (mm) of the ulcer was measured (A). At the week 12, there was a 26% reduction in ulcer size (B).

It was apparent, when examining the results more comprehensively, that all the ulcers treated in this study presented with periods of healing, where ulcer sizes would reduce significantly, and periods of regression, where ulcer sizes would increase significantly. Mechanical debridement may be held liable for these periods of ulcer size variation. The literature finds that debridement may be considered one of the most important interventions in managing ulcers; debridement not only generates a clean wound, but might also have the ability to convert a chronic wound into an acute wound with increased blood perfusion [26,27]. Podiatrists are ideal in offering wound debridement, as they have undergone extensive training [28]. According to Minatel et al [23], wound debridement complicates regular measurement of the ulcer size because it results in the impairment of margins of the ulcer, this can then be seen as controversial because it has become generally accepted to assess and judge the success of treatment by an objective measurement of wound healing [29].

When examining the ulcers in all three groups, it was obvious that they varied in terms of factors such as size, duration, etiology, and location, this highlighted the vast clinical variety of ulcerations in patients with DM managed by health care providers and podiatrists. According to Paton et al [30], the healing time and the paths of resolution in foot

ulcers depend predominately on the etiologic factors. In most patients, peripheral neuropathy and excessive pedal pressure were a common cause of ulceration, but the literature has identified other factors, such as ischemia, infection, and tissue malnutrition [27]. This method of isolating the primary causative factor and managing it accordingly is suspected to be the main reason that most ulcers in this study presented with favorable results, and it is critical when evaluating an investigational therapeutic device that is used in conjunction with standard therapy, which includes offloading [31]. According to literature, wounds due to diabetes will only resolve if the underlying pathology is corrected [32]. Previous clinical studies investigating the effect of phototherapy only managed ulcers by cleaning and dressing with 1% silver sulfadiazine cream or utilizing traditional medical treatment [23,33,34].

Aside from vasculopathy, which commonly affects patients with DM, neuropathy plays a vital role in generating ulcers in patients with DM and this may also have a major impact on the patients' health-related quality of life. The health-related quality of life in such patients with lower-limb ulcerations is sufficiently lower than those patients without ulcers [35]. Although some patients in all three groups reported discomfort during irrigation and debridement of the ulcers, literature has classified this form of pain as acute pain associated with

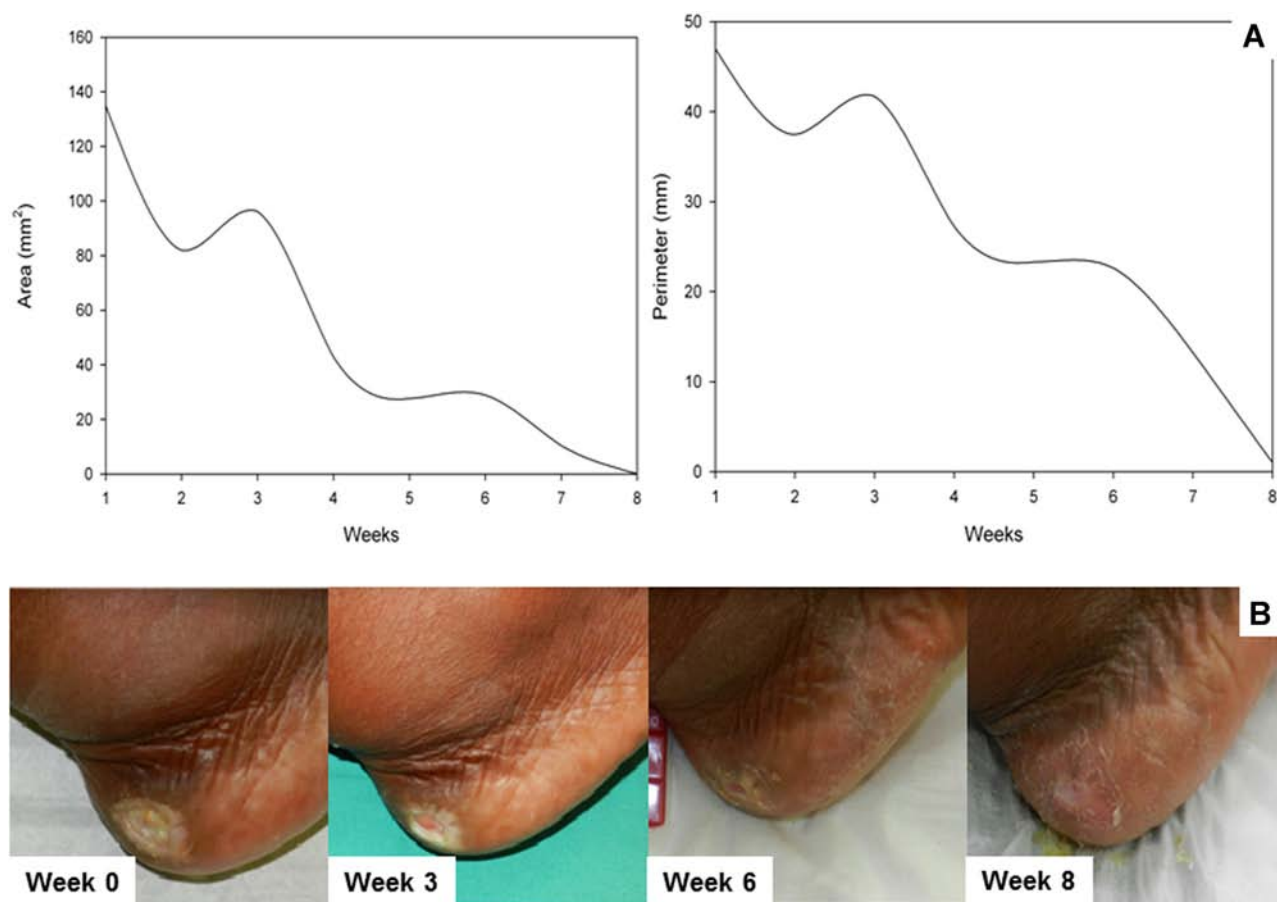


Fig. 6 – Case 6. A 53-year-old African female with an ulcer on the posterior aspect of the right calcaneus. Both the ulcer and regional lymph nodes were treated with phototherapy and the ulcer treated with standard podiatric interventions. The area (mm²) and perimeter (mm) of the ulcer was measured (A). At 8 weeks the ulcer had completely resolved (B).

the condition [36]. None of the participants in this study complained primarily of severe pain related to the lower-limb ulcerations, but all participants in group 2 and group 3 reported a significant decrease in ulcer discomfort and occasional sharp pains. This is consistent with other clinical and experimental studies that demonstrated the ability of phototherapy to promote an increase in nerve functional abilities and regeneration of injured nerves [37,38].

Infection may not be a direct factor in the formation of ulcers, but it plays a major role in impairing the normal stages of healing. When a patient with diabetes presents with a chronic open foot wound, healing is hampered at times by both physiologic barriers and increased susceptibility to wound infection [28]. In this study, a combination of topical, oral, and intravenous antibiotics were used when necessary to combat the invading micro-organisms. This was further assisted by the use of silver dressings. Infection played a critical role in determining the progress of wound healing and also had an effect on the overall healing process.

General lower-limb and foot care should be further emphasized to patients with DM, especially geriatric patients, in order to adequately manage and prevent lower-limb ulcerations. Literature has identified that there are some difficulties associated with managing patients with DM [38,39]. This generally results in poor patient compliance with therapy,

which has a major impact on the progress and rate at which chronic ulcers due to diabetes will resolve.

5. Conclusions

Uncovering a method or treatment plan to help resolve chronic lower-limb ulcerations due to diabetes remains a rather difficult task in clinical practice [28,36]. There are currently no clinical studies in South Africa that have attempted to investigate the use of phototherapy to manage ulcers in the lower extremities, and no studies that have looked at the combined effect of phototherapy and podiatric management and treatment. This pilot study demonstrated that treating patients with phototherapy in combination with podiatric intervention was advantageous compared with treating ulcers with podiatric methods alone. Treating both the ulcer and the regional lymph nodes had no significant effect compared with irradiating the ulcer only; however, this needs to be further studied in a larger study group. This study also showed that the treatment of chronic ulcers in patients with diabetes twice a week had a beneficial effect on the healing of the ulcer. There was significant heterogeneity in the wounds treated in the individual groups, which makes a fair comparison difficult. It is evident from the results of this

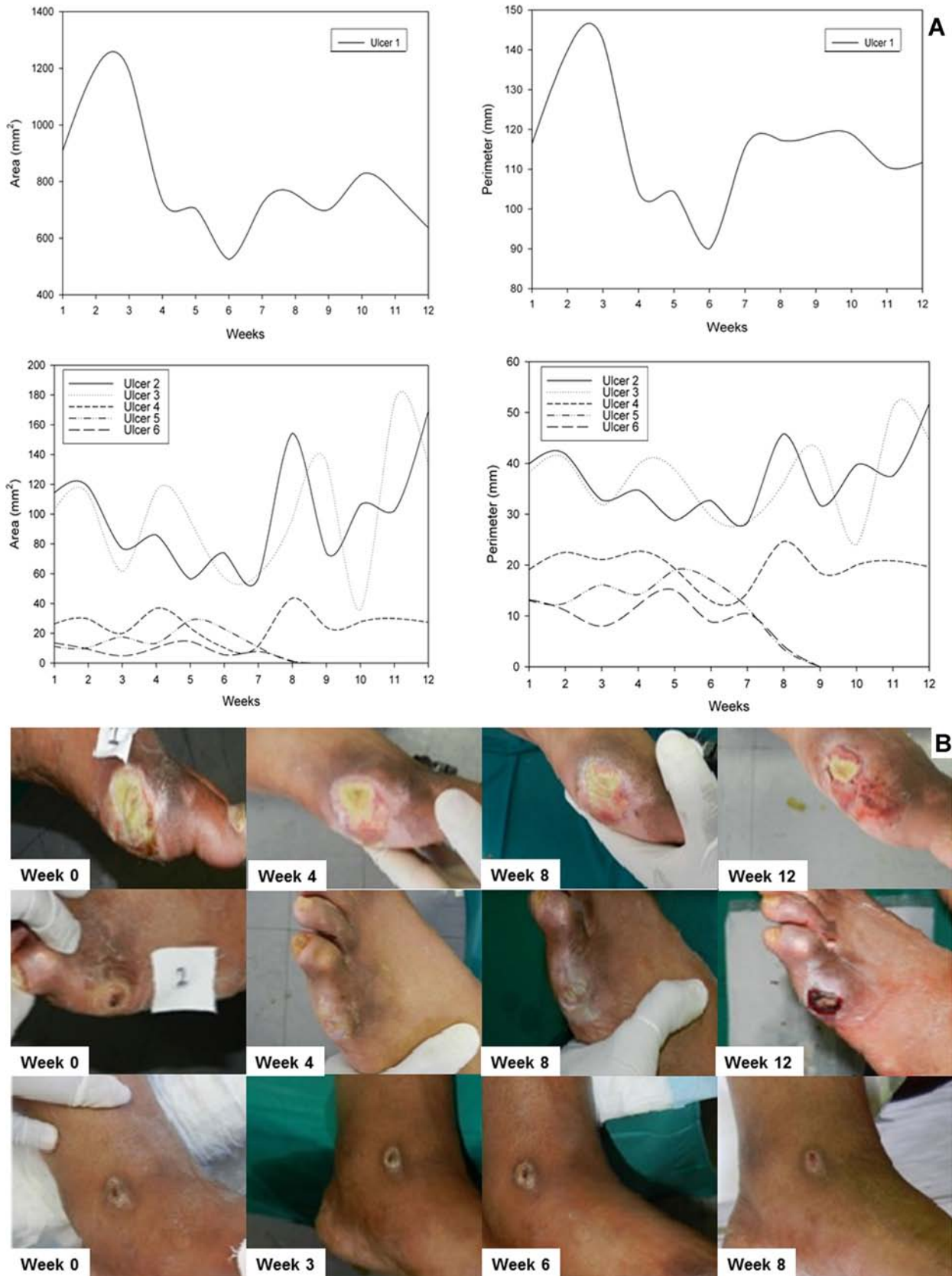


Fig. 7 – Case 7. A 67-year-old Coloured male with six lower-limb ulcerations. Both the ulcers and regional lymph nodes were treated with phototherapy and the ulcers treated with standard podiatric interventions. The area (mm²) and perimeter (mm) of the ulcers were measured (A). By week 12, ulcer 1 had resolved by 30% (B, top row). Ulcer 2 increased by 48% by week 12 (B, middle row). Ulcer 6 had completely resolved by week 8 (B, bottom row). In South Africa, the term “Coloured” is an ethnic label for people of mixed ethnic origin who possess ancestry from Europe, Asia, and various Khoisan and Bantu ethnic groups of southern Africa.

study that a larger study in the treatment of lower-extremity ulcers with phototherapy, which will give more reliable and statistically viable results, is warranted.

Acknowledgements

University of Johannesburg and the National Laser Centre/ Council for Scientific and Industrial Research/National Research Foundation rental pool program provided financial support for the conduct of the research. These funding sources had no involvement in study design, data collection, analysis and interpretation, or in writing of the report and decision to submit the article for publication.

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