Digital ulceration resulting from digital vasculopathy is reported to occur in 30% to 60% of patients with systemic sclerosis (SSc), or scleroderma. Severe digital vasculopathy may occur in either the diffuse cutaneous form (dcSSc) or the limited cutaneous form (lcSSc) — formerly known as CREST syndrome, an acronym for its hallmark characteristics of calcinosis, Raynaud’s phenomenon, esophageal motility dysfunction, sclerodactyly, and telangiectasia. The multifactorial etiology of these skin ulcers, typically around digital joints, reflects the multifaceted nature of this disease. Ischemia due to vascular disease (Raynaud’s), skin tightening over digits (sclerodactyly), dry skin (Raynaud’s), mineral crystal deposits under the skin (calcinosis), and microtrauma

Acoustic Pressure Wound Therapy in the Treatment of a Vasculopathy-Associated Digital Ulcer: A Case Study

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Digital vasculopathy and subsequent digital ulceration are common and painful complications of limited cutaneous systemic sclerosis. Although the use of hydrocolloid occlusive dressings has been found to reduce pain, frequently required surgical or chemical debridement can be intensely painful in such ulcers. Acoustic pressure wound therapy is a noncontact, low-frequency ultrasound therapy used for painless debridement in a variety of acute and chronic wounds. It was administered to treat an intensely painful, methicillin-resistant Staphylococcus aureus-infected finger ulcer resulting from peripheral, bilateral vasculopathy in a 68-year-old man with a history of three prior fingertip amputations secondary to limited cutaneous systemic sclerosis-associated digital vasculopathy. At treatment initiation, 90% of the 11 cm² wound was covered with firmly adherent fibrin slough. Acoustic pressure wound therapy was performed three times weekly for 5 minutes per treatment and the wound was covered with a hydrocolloid occlusive dressings. Pain scores decreased from 10 (visual analog scale, 0 = none, 10 = extreme) at the beginning of treatment to 0 at the week 8 assessment and his analgesics were discontinued. After 10 weeks (31 acoustic pressure wound therapy treatments), the wound was completely closed.

Key words: acoustic pressure wound therapy, debridement, noncontact ultrasound, wounds

contribute to cutaneous digital ulcer formation. Slow healing of digital ulcers in patients with underlying SSc is common and can be attributed to poor blood flow and tissue oxygenation, epidermal thinning in patients with longstanding disease, and skin tightly stretched over joints. The slow healing process renders these ulcers particularly vulnerable to infection.

Digital ulcers in patients with SSc are associated with pain (often extreme), scarring and digital resorption, and severe impairment of finger and hand function. Ulcer infection, which can lead to osteomyelitis or other serious soft tissue infection, may require either oral or parenteral antibiotics. The current standard of care for patients with SSc includes pharmacologic therapies to manage the SSc conditions that contribute to digital ulceration. These include vasodilators to treat Raynaud’s phenomenon and pulmonary arterial hypertension (PAH), endothelin-receptor antagonists for PAH and prevention of digital ulceration, and various antiplatelet, anticoagulant, and antithrombotic agents to maintain vascular integrity and manage PAH.

From a wound care perspective, the optimal therapy for these challenging ulcers has not been established. Hydrocolloid membrane occlusive dressings have been shown to speed healing of SSc-associated digital ulcers and reduce associated pain when compared with control treatment. However, surgical or chemical debridement of necrotic tissue often is required and can be very painful. It is generally accepted that acoustic pressure wound therapy (APWT), a noncontact, low-frequency, nonthermal ultrasound therapy to accelerate healing, cleanse, and debride, is not associated with treatment-related pain. On the contrary, results of a small retrospective study suggest that APWT may even provide a palliative benefit in painful wounds. Acoustic pressure wound therapy delivers acoustic energy to the wound bed via a fine, sterile, saline mist. The potential cellular effects of APWT on the wound healing process and the clinical studies demonstrating improved wound healing compared with conventional wound care have been described previously. Additionally, Kavros et al observed the destruction of bacterial cell walls in vitro after APWT administration.

Case Report

In June 2006, a 68-year-old man with lcSSc, including peripheral bilateral hand vasculopathy, developed a painful ulcer on the lateral aspect of the second knuckle on the left second finger. His medical history includes three prior fingertip amputations secondary to digital vasculopathy, coronary artery stent placement, hernia repair, cervical laminectomy, cholecystectomy, and the following concomitant medications: minocycline 100 mg twice daily, aspirin, and diltiazem as needed. He was initially treated at a large hospital wound care center but when sharp debridement proved too painful the wound was wrapped in saline-soaked hydrofiber dressing with silver and covered with petroleum gauze, roll gauze, and finger netting. The patient was instructed to change the dressing daily and return to the clinic in 4 months.

On July 14, the patient became concerned about the slow progression of healing and sought treatment at the author’s center. Conservative surgical debridement of eschar (one treatment) was performed, but the patient’s extreme pain in response to debridement prevented removal of the firmly adherent fibrin and yellow slough. At this time, the wound culture was positive for community-acquired methicillin-resistant Staphylococcus aureus (MRSA), which was treated with tetracycline 250 mg twice daily. The wound was dressed with antimicrobial alginate (SILVERCEL®, Johnson & Johnson, Somerville, NJ) and extra-thin hydrocolloid occlusive dressing (DuoDERM® Extra Thin, ConvaTec, Princeton, NJ) to promote autolytic slough debridement. On July 16, wound area measured 8.14 cm²; sodium chloride dressings also were used at this time. Oxycodone (one to two tablets every 4 hours when needed) and extended-release morphine sulphate (15 mg twice daily) were required for pain management.

On July 26, wound area had increased to 11.1 cm² and APWT treatment (MIST Therapy® System, Celleration, Inc., Eden Prairie, Minn) was initiated three times weekly for 5 minutes per session. The
use of extra-thin hydrocolloid dressings over calcium alginate with silver was continued. After 4 weeks of APWT (August 25), the dressing was changed to a collagen matrix with silver (Promogran Prisma Matrix®, Johnson & Johnson) under the hydrocolloid occlusive dressing.

Wound area decreased from 11.1 cm² at APWT initiation to complete closure (see Figure 1) after 31 APWT treatments over 10 weeks (July 26 to October 4). Four weeks into APWT (August 25), wound pain had diminished from a patient-reported rating of 10 out of 10 on the visual analog scale (VAS) to 6 out of 10. At week 5, the patient’s pain score was 4 out of 10 and, by week 6, the patient was pain-free and no longer required narcotic pain medication.

**Discussion**

Digital ulcers and underlying digital vasculopathy in SSc patients are associated with serious complications, including functional disability, gangrene and critical ischemia, and the need for digital sympathectomy or digital amputation. Currently, no clear “best practice” is proliferated for the care of these challenging wounds that are complicated by substantial underlying vascular and autoimmune disease.

The use of a hydrocolloid occlusive dressing for digital ulcers is supported by a prospective, randomized trial; however, debridement is often necessary as well. In the current case, a patient with lcSSc and an infected, painful digital ulcer averted a fourth fingertip amputation arising from digital ulceration. This outcome, achieved with 10 weeks of APWT added to the conventional hydrocolloid occlusive dressing, stands in contrast to the outcomes of this patient’s three previous digital ulcers, which resulted in fingertip amputation (patient records from treating facility not available). In this patient, APWT was able to remove extensive, firmly adherent fibrin slough from an MRSA-infected wound where surgical debridement could not be tolerated due to intense pain.

The absence of pain associated with APWT is likely attributable to the fact that acoustic pressure delivered via a fine saline mist does not produce palpable mechanical pressure on the wound bed. The possibility that this acoustic energy may even provide a palliative benefit has been documented only in a very small retrospective study and requires additional prospective investigation. Similarly, the preliminary evidence of bactericidal effects with APWT warrants expanded laboratory and clinical investigation.

The results of a small case series suggest that rhythmic external compression of the limbs (20 1-hour sessions) also may help heal digital ulcers in SSc patients. Additionally, a case report has described successful treatment with hyperbaric oxygen therapy (30 treatments) in a non-healing, SSc-associated digital ulcer. In addition to wound-specific care, pharmacologic agents for managing Raynaud’s phenomenon and maintaining vascular integrity may assist in healing digital ulcers. Vasodilating agents used to manage Raynaud’s phenomenon have shown some benefit in healing digital ulcers, but intolerable side effects often preclude the use of therapeutic doses. In a randomized, double-blind, placebo-controlled trial of 122 patients, the endothelin-receptor antagonist, bosentan, was shown to reduce the rate of new ulcer development in patients with lcSSc, but did not improve healing. Several prostacyclin agents have been reported in clinical trials to either prevent (oral epoprostenol

![Figure 1. Healing progression of a digital vasculopathy ulcer over 10 weeks (July 26 – October 4) of acoustic pressure wound therapy.](image-url)
or beraprost sodium, intravenous iloprost, and treprostinil subcutaneous infusion) or aid healing of (intravenous iloprost and treprostinil subcutaneous infusion) SSc-associated digital ulcers. Case series studies of 10 and 20 patients, respectively, have suggested potential roles for sildenafil\(^1\) and N-acetylcysteine\(^3\) in healing digital ulcers. Surgical procedures for nonhealing digital ulcers include microsurgical revascularization, digital arterial reconstruction, and digital sympathectomy.\(^4\)

**Conclusion**

Acoustic pressure wound therapy is generally utilized in the care of pressure, venous, arterial, surgical, trauma, and neuropathic ulcers. However, its indication — to promote wound healing through cleansing and maintenance debridement by removing fibrin, yellow slough, tissue exudates, and bacteria — is not wound-type specific. Based on the complete healing of this infected digital ulcer at risk for fingertip amputation and the lack of treatment-associated pain, APWT also may provide clinical benefit in the treatment of painful digital ulcers in the complex milieu of systemic sclerosis.\(^1\)

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**References**