

Aggressive Mechanical Bioburden Control Improves Wound Healing: Liberal 22.5 KHz Ultrasonic Debridement Reduces Bioburden

Refractory Ischemic Ulcers



Right 5th metatarsal head ulcer present for 10 months. Pain made sharp debridement a futile exercise. Note rubor swelling and maceration of the forefoot.

Three ischemic ulcers on R foot after 10 months of futile advanced weekly wound therapy, including 3 months of resource intensive NPWT. Patient steadfastly refused a R BKA. Observe the maceration due to wound exudates. Exudates decreased dramatically after the first ultrasonic aided debridement.

Problems:

- Previous L BKA
- Paraplegia with knee contractures
- Profound arterial ischemia (ABI 0.0)
- Concurrent tobacco use
- Pressure on R ankle from mobility chair
- Little progress with 10 months of advanced wound care
- Refused R BKA



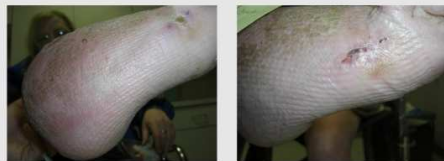
Debridement with 22.5KHz hand piece. Note extensive fibrinoid exudates containing chronic biofilm between the Longitudinal Yarn Compression stocking's fuzzy yarns. We had been "ignoring" this fibrinoid material for about 10 months. Sharp debridement was exquisitely painful. Patient refused sharp debridement and refused BKA.

Treatment:

- Three ultrasonic* debridements (22.5KHz) to control bioburden at 7 day intervals
- HEMA nano particle powder**
- Yarn Focused Compression stocking^{††} directly on the granulating surface to control edema
- BioEngineered Skin Substitute grafting[†]



R ankle 5 weeks post cultured human skin grafting healing 80% complete.



5th metatarsal ulcer healed in 5 weeks after three ultrasonic debridements and BioEngineered Skin Substitute.

Outcome:

- 100% healing of 5th metatarsal head ulcer
- 80% healing of ankle wound area in 5 weeks
- Three ultrasonic debridements reversed 10 months of stalled healing and expensive, futile care. Ultrasonic debridement controlled bioburden in granulation tissue allowing BeSS graft to heal on a refractory ischemic ulcer

Idiopathic Diabetic Ulcers



Patient referred from community wound center. Wound healing "stalled" after 7 months of treatment with honey.



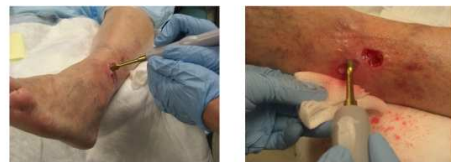
Painful diabetic ulcers refractory to 7 months of community wound center therapy.

Problems:

- L lateral ankle ulcers treated in community wound center for 7 months
- Ulcers with uncertain origin. Thus "diabetic ulcers" by exclusion
- Palpable pedal pulses
- Ulcers are painful; Sharp debridement excruciatingly painful
- Diabetic - Insulin x 14 years

Treatment

- Two debridements, 22.5 KHz ultrasonic hand piece*, at weekly intervals
- Wounds grafted with BioEngineered human Skin Substitute^{††}



Left ankle wounds are deep and painful. Observe scant granulation tissue and no migration of epithelial cells from wound edges.



Wounds healed 9 weeks after ultrasonic debridement x 2 and BioEngineered human Skin Substitute.

Outcome:

- Wounds healed 9 weeks after BeSS grafting
- Debridement of bioburden with 22.5KHz ultrasonic energy hand piece x 2, jumpstarted healing in a wound stalled (getting deeper, not granulating) for 7 months
- Ultrasonic debridement was "comfortable" for the patient who had endured multiple sharp debridements

Recurrent Venous Stasis Ulcers



Patient "bounced back" to wound clinic with recurrent R calf stasis ulcers. Language barrier and limited resources are obstacles.

Problems:

- Recurrent painful R calf stasis ulcerations
- Chronic skin fibrosis and massive edema



R calf wound one week after sharp debridement. Ulcers are exquisitely painful. Serum weeps from the wound. Note curette in background. Patient was NOT happy with sharp debridement.

Extensive scarring and fibrosis of skin surface gives this chronic stasis ulcer the appearance of a burn.



Note macerated necrotic skin around the ulcer edges. After four weeks of sharp debridement with scalpel and curette, this wound supports a large bioburden.

Note presence of cornrow furrow in the granulating surface. Furrows result from fuzzy yarn compression in contact with the healing surface. This photo, two weeks after a single ultrasonic powered debridement with 22.5 KHz hand piece, showed dramatic improvement.

Treatment:

- Five weeks of Longitudinal Yarn Compression^{††} as first layer of a four layer dressing before grafting
- A single debridement with the ultrasound powered hand piece* cleaned up the wound (presumably dramatically lowered bioburden) enough to support skin graft
- Two weeks after ultrasonic debridement, BioEngineered human Skin Substitute[†] grafting



Five weeks after cultured human skin grafting, BeSS, and 7 weeks after a single acoustic debridement, wound is declared to be "Healed!" Note how robust the skin appears: no edema, no redness.

Outcome:

- Dramatic healing seven weeks after ultrasonic debridement and five weeks after grafting ulcers with Bio Engineered human Skin Substitute

Stasis Ulcers with Ischemia on Steroids



Veteran of the occupation of Japan with painful stasis dermatitis.

Problems:

- Painful stasis ulcers present for 13 months
- Steroid dependent COPD
- Occlusive vascular disease



Note the erythema and swelling in skin around the ulcers due to severe stasis dermatitis.



Patient (and family) self referred after several months of treatment with enzymatic debridement in a community wound center. No sharp debridement had been done.



This photo, showing the wound after a painful, unsuccessful session of sharp debridement with scalpel and curette, was taken five minutes after the photo above. Several clinic visits later, a single ultrasonic debridement completed the debridement with minimal discomfort.

Treatment:

- Four layer dressing with Longitudinal Yarn Compression^{††} textile as the base layer for about 30 weeks
- HEMA nanoparticle powder** dressing used for 12 weeks
- Sixteen weeks after cultured human skin grafting, three small stubborn ulcers remained unhealed
- Three acoustic powered* debridements at weekly intervals "cleaned up the wound" Presumably biofilm was the culprit that blocked complete healing
- A second graft of BioEngineered human Skin Substitute[†] accomplished complete healing



Note improvement in the appearance of the skin. Longitudinal Yarn Compression Stockinet has dramatically improved stasis dermatitis.

Outcome:

- After ultrasonic debridement x 3, which presumably controlled bioburden, a second graft of BioEngineered human Skin Substitute accomplished complete healing sixteen weeks after the first BeSS graft

Stasis Ulcer, CHF and Senile Skin



Stasis ulcer at the classic location above the medial malleolus is surrounded by edematous skin with senile changes. Note the healing pretibial shear injury.

Problems:

- Classic L medial calf stasis ulcer
- CHF with edema
- Senile skin with healing pretibial shear wound



Ultrasonic debridement underway at first wound clinic visit. Superficial debridement revealed a 1cm deep organized hematoma with extensive necrotic fat.



Ultrasonic debridement #2. Note decrease in swelling and redness around the wound.

Treatment:

- Weekly acoustic debridement X 3*
- Longitudinal Yarn Compression^{††}



Four weeks of compression therapy.



Six week after initial ultrasonic debridement, wound is healing by contraction and epithelial migration.

Outcome:

- Wound nearly healed in six weeks with three weekly ultrasonic debridements and elastic longitudinal yarn compression

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*SonicOne®, Misonix, Farmingdale, NY
**Altrazeal®, ULURU Inc., Addison, TX
††Apligraf®, Organogenesis Inc., Canton, MA
††EdemaWear®, Compression Dynamics LLC, Omaha, NE

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Problem: Bacteria secrete a mucous biofilm to survive in chronic wound granulation tissue. Bacteria exploit biofilms to attach to granulation tissue, resist drying and evade antibiotic therapy. Biofilms bacteria inhibit healing via multiple mechanisms. Clinical research suggests aggressive bioburden control dramatically speeds healing. The iconic paradigm of aggressive debridement of necrotic tissue is expanding to include aggressive mechanical control of biofilms.^{1†}

Mechanism of bioburden control is a challenge for surgeons aggressive with curette, scalpel and sronger. Biofilm is invisible. Looking great... granulating wounds carry heavy bacterial bioburdens which are ignored. Biofilm is impossible to debride sharply without disrupting healthy tissue below the healing interface. Sharp debridement is disrupted by patients, blood and time consuming, hence other surgical options are sought.

Ultrasonic 22.5 KHz wound debridement: exploits vibration and cavitation to separate friable granulation bioburden from the wounds without disrupting the healing surface. Patient comfort, ease of use (ancillary staff easily master handpiece technique) and brevity of treatment makes ultrasonic debridement for bioburden reduction practical.

Methods: Seven "training curve" patients were treated with 22.5 KHz ultrasonic debridements at weekly intervals to control bioburden. Photos document healing.

Results: Four of seven patients had stalled wounds, wounds under treatment for more than 90 days, when ultrasonic debridement was initiated. These stalled wounds "cleared up" after one or more ultrasonic debridements to a point where bioengineered human skin substitute grafting was feasible and successful.

Conclusions: Utilization of 22.5 KHz ultrasonic debridement for chronic, but otherwise "good looking" granulation tissue to control biofilm speeds healing in stalled wounds. The iconic paradigm, aggressive debridement of necrotic wound tissue, appears to need a tweak, to include aggressive mechanical control of wound bioburden.

References: 1. James, G. et al. "Biofilms in Chronic Wounds." Wound Repair and Regeneration, Volume 18, Issue 1, Pages 37 - 44. 2. Davis, M. et al. "Ultrasonic therapy for recalcitrant diabetic foot ulcers: results of a randomized, double-blind, controlled, multicenter study." Ostomy Wound Management 2007; 53(9):34-38. 3. Spang, Margaret McCarty, et al. "Wound Debridement with 23 KHz Ultrasonic." Advances in Skin & Wound Care, November/December 2005 - Volume 18, Issue 9, pp 448-450.

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