Activated Carbon Cloth in Contact with Venous Leg Ulcer Granulation Tissue is Synergistic with Fuzzy Wale Focused Elastic Compression Therapy

Problem

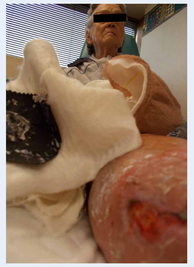
- 76 yo with Traumatic R Leg VLU
- Senile skin
- Congestive Heart Failure with Edema
- Painful wound- intolerant of elastic compression Rx

Traumatic R lateral VLU 11/22/12 seen here after two weeks of Robert Jones cotton batting dressing for compression, topical hypochlorous acid (HOCl) for biofilm control and sharp curette debridement to control wound bioburden. Wound was exquisitely tender and elastic compression was painful.

R lateral calf traumatic VLU shows little improvement after 2 weeks of Robert Jones dressings for compression. Photo shows white necrotic macerated fibrinoid tissue that resisted mechanically debridement and topical hypochlorous acid. Observe that there is almost no evidence of healing at 2 weeks. Pedal Doppler signals are present. Zinc oxide crème was used to prevent moisture associated skin damage from weeping edema fluid.

Treatment

- Mechanical Debridement
- 3 layer dressing
- Activated Carbon Cloth* is added as a contact layer + 3 layer compression dressing at day #14



Week #3: Note the Activated Carbon Cloth (ACC), seen in background, after one week as a biologically active contact layer. ACC controls the biofilm bacteria that inhibit VLU healing. Note the shiny glaze of wound exudate that has dried on the patient side of the carbon cloth.
In spite of poor quality photograph, observe that 30% of the wound surface, from the edge toward the center, has re-epithelialized in one week. This patient has a great result after just one week of carbon cloth in contact with the granulation tissue. Decision was made to try ACC a second time.

Photos show VLU after one week of profore type dressing + active carbon cloth (ACC). Note how the wound has re-epithelialized from the edges. Healing 30% of the wound area in one week is a positive response to ACC as a biologically active contact layer that suppresses bacterial growth in wound biofilm.

Wound, estimated by staff to have healed by 60 %, using active carbon cloth over a 2 week period, see prior photo, with 3 layer compression + active carbon cloth as a contact antimicrobial layer. Observe old hemorrhage, on the wound edge, a result of prior curette debridement. Note robust epithelial daughter cells now striving to cover the wound. A decision was made to use a curette to debride this wound at this visit.
Wound pretreated with wash cloth soaked in topical hypochlorous acid (HOCl) 250ppm solution to soften the proteinaceous eschar. A curette was used to remove bioburden from the healing surface and surrounding wound. Observe how the healthy granulating wound bed now in "transition" with epithelial daughter cells now dividing in the central wound base and closing the wound edges. Compare this photo to photos from prior week to get a sense of how effective activated carbon is as a wound contact layer.

This photo shows active carbon cloth dressing, and the bloody exudates that drained through the carbon cloth onto cast padding over one week. Observe wound exudate that passed through the active carbon cloth absorbed into the cast padding of a three layer compression dressing.
In broad stroke generalities, we now know all wounds heal via epithelial daughter cells that are derived from circulating epithelial cell precursors (CEP). CEPs are recruited to the wound bed from bone marrow stem cells. Current thought is that biofilm bacteria inhibits healing, in the main, by releasing inflammatory mediators that act in myriad ways to suppress division and growth of the multiple generations of daughter cells that are required to cover a wound with epithelial cells. Active Carbon Cloth* appears to down regulate negative effects of biofilm and to speed daughter cell growth.
Similarly, circulating epithelial cell precursors (CEP) daughter cell growth may be the primary physiological mechanism behind elastic textile compression, described by Dr. Gerson Unna in Hamburg Germany in 1910, to heal venous leg ulcers (VLUs). Elastic compression is required to heal VLUs but the physiology of exactly how external elastic compression therapy works is poorly understood. Elastic compression, we conjecture, drives evil VLU humors out of the wound bed granulation tissue to create a hospitable nursery for epithelial daughter cell growth.

In this photo activated carbon cloth (ACC) with no covering layer to buffer the activated charcoal surface, is used as a thin contact layer directly on the wound surface. Two more layers were wrapped on top of the carbon cloth.
Active carbon cloth, activated charcoal, in direct contact with biofilm and exudate on the wound surface, acts to suppress biofilm bacteria in multiple ways that are poorly understood. Carbon cloth: the contact layer in this photograph, overlaps the venous leg ulcer. Activated charcoal: the black powder that is the active ingredient in the contact layer, overlaps the wound bed.
Activated charcoal is porous and has a large fractal surface, estimated to be as high a 500 square meters per gram. The surface chemistry of activated carbon molecules is the result of weak induced dipole chemical bonds, similar to the hydrogen bonds that hold DNA base pairs together. Induced dipole bonds were described by physicist Fritz London, a German physical chemist and contemporary of Einstein. The chemical bonds that result from weak induced dipoles on the carbon surface, bad metaphor ahead, make the neighborhood inhospitable for bacteria, fungi and virus to reproduce and to survive.
Weak, induced dipole, London chemical bonds make carbon cloth magic for clearing odor from, say vented colostomy bags or in dressings for wounds with malodor. For this patient we exploit the weak induced dipole chemical bonding sites exposed on the fractile carbon surface to "disrupt bacterial domestic tranquility". Activated charcoal absorbs molecules that result from myriad enzymatic reactions that occur outside the bacteria cell wall and bacteria cannot reproduce.

Carbon cloth is the contact layer in a three layer dressing. Activated charcoal has a large fractal surface, as high a 500 square meters per gram. The chemistry of activated carbon molecules relies on weak induced dipole chemical bonds, similar to the hydrogen bonds that hold DNA base pairs together, described by physicist Fritz London, a contemporary of Einstein in Germany. London forces make carbon cloth magic for clearing odor from, say vented colostomy bags or in dressings for wound with malodor.
We are exploiting the weak induced dipole chemical bonding sites exposed on the fractile carbon surface to "disrupt bacterial domestic tranquility". Activated charcoal absorbs molecules that result from myriad enzymatic reactions that occur outside the bacteria cell wall and bacteria cannot reproduce.

Outcome

- Activated Carbon contact layer used at day #14 results in 30% healing in 7 days
- Complete healing at 6 weeks

VLU on 12/18/12 is 85% healed at week 5 with three weeks of activated carbon cloth in direct contact with the wound surface biofilm. No healing had occurred in the initial two week period before activated carbon was used as a contact layer. This case encouraged us to study bare carbon cloth as an improved surface contact layer for venous leg ulcer (VLU) layered elastic compression dressings.

Conclusion

- Activated Carbon Cloth (ACC) in contact with granulation tissue + elastic compression therapy speeds healing of VLUs
- ACC inhibits inflammation due to biofilm bacteria to improve survival of circulating epithelial cell precursors (CEPs)

Problem

- VLU refractory to 11 weeks of advanced wound clinic Rx
- Morbid Obesity
- Sleeps sitting up to prevent apnea, Pickwickian syndrome
- Massive edema with weeping lymphorrhea
- Noncompliant with CHF Rx
- Tracheotomy, pulmonary hypertension
- Thick exuberant granulation tissue

Observe the raised edges of the venous leg ulcer (VLU) evidence of poorly controlled edema around the wound. Observe thick layer of shiny wet granulation tissue. Granulation this L.L. pedal calf VLU was weeping fluid, soaking pants and clothes and bedding. Weeping lymphorrhea is a red flag, saying "expect a long siege, healing will be delayed." Weeping lymphorrhea is a critical comorbidity that predicts healing will take months. Accordingly we planned to step up to advanced wound healing modalities in first month.
Comorbidities: non-diabetic, chronic VLU (wound present > 12 weeks) weeping lymphorrhea from wound surface, noncompliant with CHF therapy, morbid obesity, tracheotomy, pulmonary hypertension due to obesity, sleeps sitting up to prevent apnea leading to leg edema and has swelling due to "Pickwickian legs".

Treatment

- Slow response to 14 weeks of 3 layer compression
- Active carbon cloth* + wrapped foam compression

An ultrasonic powered hand piece with hypochlorous acid irrigation fluid was used to debride wound in the wound clinic. Vinyl bag traps bloody irrigation fluid.

Pretreatment with topical hypochlorous acid* on a wash cloth is used to soften the eschar prior to "soft debridement" with dry terry cloth. Observe the fibrinoid exudate on the terry cloth. Note iatrogenic breakdown of macerated pretibial skin, the result of one week of honey alginate used under a compression dressing on a highly exudative VLU.

Active carbon cloth as the contact layer + rolled foam 2 layer compression dressing. From this point, at ~ 14 weeks of biweekly dressing changes, the wound went on to healed 40% in two weeks. Active carbon cloth inhibits biofilm bacteria.
Active carbon cloth has a huge reactive surface area estimated to have surface area as high as 500 square meters per gram. Carbon atoms exposed on the surface of the activated charcoal react with biologic molecules via weak induce dipole chemical bonds. How these exposed carbon atom prevent bacterial from thriving without poisoning eukaryotic cells in the granulation tissue is poorly understood and rarely utilized in direct contact with wound biofilm in the care of chronic venous wounds under compression.

One week of carbon cloth as contact layer has produced dramatic wound healing (~ 40% reduction in wound surface area in two weeks, wound now 80% closed after 16 weeks of biweekly dressing changes. Observe dramatic improvement of stasis dermatitis in surrounding skin.

After 2 weeks of Active Carbon Cloth in contact with the wound, observe dramatic improvement in epithelial daughter cell growth at wound margins. We believe that biofilm disrupts epithelial daughter cell reproduction in the wound bed. Activated charcoal (ACC) as a wound interface is a powerful contact inhibitor of biofilm bacteria. Activated charcoal appears to be a potent, sustained effect on this wound, enabling the epithelial daughter cells to cover 40% of the wound edges in 2 weeks, as seen in the photo. We used sharp curette debridement to remove the friable exuberant mucoid granulation tissue at the center of the wound.

Outcome

After 5 months of Rx activated charcoal therapy* + foam wrap compression heals VLU in 5 weeks

Wound 98% healed, photo date 12/18/12, after five weeks of Active Carbon Cloth. Pink material on wound is a zinc oxide based anti-inflammatory paste containing five Chinese traditional medicine herbs.

Conclusion

Activated charcoal therapy appears to have enhanced effectiveness of elastic compression therapy

Problem

New biomaterials advance wound healing. Wound science describes the underpinning biomaterial physiology, for example: 1. the positive charge on powered chitin from shrimp activates thrombin and staunches battle field wound bleeding from IED injuries, 2. rayon gauze coated with DACC (dialkyl carbamoyl chloride), a hydrophobic lipid, "upsets" biofilm bacteria to speed healing, and 3. nanosphere Hydroxyethylmethacrylate (HEMA), a hydrophobic polymer used in soft contacts, "upsets" biofilm bacteria to enhance healing. 1,2
As a biomaterial, activated charcoal is known for example by the meat packing industry, to be a powerful local inhibitor of microorganisms. Activated carbon cloth (ACC) has a huge fractal surface area, 1,000 – 2,000 meters2 per gram, that exposes highly reactive carbon atoms to interact with biologic molecules via weak London Forces disrupting bacterial physiology.3
Developed for chemical warfare in the '60s, ACC is widely used to control malodor in ostomy appliances and wound dressings.4
Historically ACC dressing design has not had the active carbon molecules in direct physical contact with wound granulation tissue to fully exploit the London force.
This study asks two questions, is activated charcoal a superior contact layer when delivering elastic compression therapy to:
1. treat venous leg ulcers, VLUs and ,2. treat periwound stasis dermatitis? In stasis dermatitis, inflamed skin is at risk from maceration and bacterial colonization leading to cellulitis, the coup de grace skin disruption that presages VLU formation.

Methods

Four refractory VLU patients were treated with ACC *, ** and fuzzy wale elastic compression stockinet*** .5 Topical ointments and crèmes were avoided.

Results

Photos document all VLUs healed and stasis dermatitis improved.

Conclusions

Activated Carbon Cloth with and without silver as an antimicrobial contact layer during elastic compression therapy appears effective to: 1. decrease stasis dermatitis and 2. speed VLU healing.

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*Zorflex® Active Carbon Cloth, Calgon Carbon, Tyne and Wear, UK
**Actisorb ® Carbon Cloth with Silver (deconstructed at bedside), Systagenix, Gatwick, UK
***EdemaWear®, Compression Dynamics, LLC, Omaha, NE

Martin J. Winkler Sr., MD, FACS
Creighton University Department of Surgery (Contributed Service), Omaha, NE
University of Nebraska Department of Surgery (Contributed Service), Omaha, NE

Sara M. Winkler
Stanford University Bio Engineering, Palo Alto, CA

University of Nebraska Medical Center

Alegent Creighton Health

Problem

- Early recurrent VLU
- Recurrent VLU 3 weeks after 10 weekly clinic visits for 3 layer compression
- Senile skin

Photo shows cornrow furrows in the granulation tissue in this recurrent VLU. The ulcer came back in 3 weeks after ~ 10 weeks of clinic visits for 3 layer compression therapy. We tried carbon cloth and results were dramatic.

After three visits the recurrent VLU is not responding, so we considered "advanced" wound care products, recombinant growth factor, and bioengineered skin substitutes (human foreskin epithelia cell, human fibroblast, pig intestine, human placenta).

Treatment

- Active carbon cloth* + fuzzy wale elastic compression**

This photo shows what may be the final weekly clinic layered dressing, with ACC as the contact layer being placed. Two weeks of compression + carbon cloth contact layer has healed a traumatic recurrent VLU that did not heal in the prior 14 weeks in spite of "adequate" elastic compression, mechanical debridement of wound bioburden and topical hypochlorous acid to control biofilm bacteria. The physiology of how active carbon cloth disrupts local microbial biofilm activity is poorly understood.
Active carbon cloth has a huge reactive surface area estimated to have surface area as high as 500 square meters per gram. Carbon atoms exposed on the surface of the activated charcoal react with biologic molecules via weak induce dipole chemical bonds. How these exposed carbon atom prevent bacterial from thriving without poisoning eukaryotic cells in the granulation tissue is poorly understood and rarely utilized, until now, in the care of chronic wounds.

Outcome

Recurrent VLU heals 80% with 2 weeks of carbon cloth* + standard layer compression

Photo shows an 80% healed 4cm wound and the wound surface side of the activated carbon cloth (ACC). ACC was the contact layer of a 4 layer dressing that had been in place one week. Observe scales of dried serum and wound exudates on the active carbon contact layer. This healed traumatic VLU followed two weeks of 4 layer elastic compression + carbon cloth as the contact layer. This VLU healed in a total of 14 weeks. Five weeks of wound clinic care, reoccurrence at ~ week 10 and , now at ~ 14 weeks the active carbon cloth + compression healed the wound in two weeks.

Conclusion

Activated charcoal therapy appears to have enhanced effectiveness of elastic compression therapy