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A Study on the Ability of Coblation Therapy to Remove Various Shrapnel-Like Material and Pathogenic Organisms Using a Deep Dermal Porcine Model

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Abstract:

Debridement plays a critical role in wound management.[1,2] In addition to removing necrotic tissue, debridement may eliminate bacteria frequently harbored within the tissue. This study evaluated a novel debridement method which uses plasma-based radiofrequency technology to remove contaminated shrapnel wounds. Coblation is a patented technology that uses radiofrequency energy to excite the electrolytes in a conductive medium, such as saline, to create a precisely focused plasma.[3] This plasma field contains highly energized particles which possess sufficient energy to break tissue molecular bonds, causing the tissue to dissolve at relatively low temperatures (typically 40°C to 70°C). Eighteen (18) deep dermal wounds measuring (22 mm x 22 mm x 3 mm deep) were created on pigs.[4] Wounds were inoculated with Methicillin resistant *Staphylococcus aureus* USA300 (MRSA USA300) in combination with shrapnel and then covered with a polyurethane dressing for 24 hours. Wounds were then randomly assigned to one of three treatment groups: 1) Coblation, 2) Surgical Debridement and 3) No Debridement. Wounds were biopsied on days 0, 5, 9 and 12 and specimens were processed for MRSA counts using selective media. Comparison between coblation and surgical debridement showed a decrease in bacterial count in all assessment times. The lowest bacterial count in all assessment times was observed in wounds debrided with Coblation showing a decrease in more than 2 Log CFU/g on days 0, 5 and 9. On day 12, Coblation debrided wounds exhibited 6.10±0.22 Log CFU/g, this value represents 99.99% of reduction compared with non-debrided wounds. There was a 96% of reduction in wounds treated with Coblation compared with those surgically debrided. Reducing MRSA bacterial infection, especially of biofilm-associated organisms in combination with shrapnel, may have important clinical implications for traumatic civilian and military wounds. Further research into the use of this technology in wound management is warranted.

Introduction:

Debridement methods have shown to remove pathogenic biofilm bacteria from wounds with antibiotics for eradicating remnants to prevent restoration.[5] Infections of combat-related traumatic wounds can delay wound healing, and progress to life threatening sepsis.[6] The source of these wounds come from gunshot wounds and blast injuries caused by projected material or shrapnel that occur on open-air explosions in military conflicts.[7] Coblation uses plasma mediated ablation with an electromagnetic field within a conductive solution creating an ionized plasma to ablate and coagulate soft tissue which has shown to be effective on reducing bacteria.[8,9] This study evaluates the efficacy of coblation compared to surgical debridement in reducing the MRSA USA300 burden in infected shrapnel-containing wounds using a porcine model.

References

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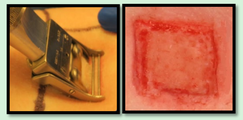
Materials and Methods:

1. Experimental Animals:

Swine (2) were used as our experimental animal due to the morphological, physiological, and biochemical similarities between porcine skin and human skin.[10]

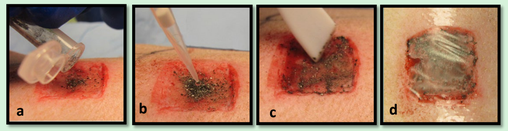
2. Wounding Technique:

A specialized electrokeratome was used to create Eighteen (18) deep dermal reticular wounds measuring (22mm x 22mm x 3mm deep) on the paravertebral and thoracic area of each animal.

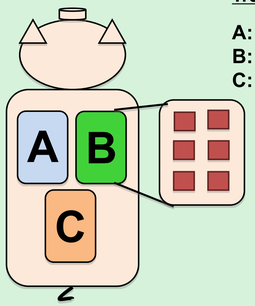


3. Inoculation:

- 100mg of sterile shrapnel material was distributed in the center of each wound (photo a).
- 25µL of Methicillin Resistant *Staphylococcus aureus* (MRSA USA300) being inoculated (10^6 CFU/mL) into each wound (photo b).
- The inoculum and shrapnel material were scrubbed into each wound with a teflon spatula for 10 seconds (photo c).
- All wounds were then covered with a polyurethane film for 24 hours to allow biofilm formation (photo d).



4. Experimental Design:



Treatment Groups

A: Coblation (Default = 7)
B: Surgical Debridement
C: No Debridement

Assessment Times:

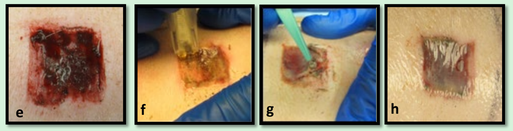
Animal #1 (Days)* 0 and 5

Animal #2 (Days)* 9 and 12

* After Treatment application

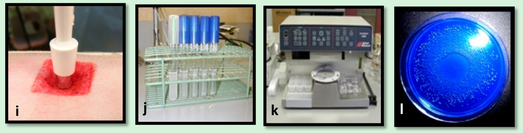
5. Treatment Regimen:

- After 24-hour biofilm formation (photo e), all wounds were treated with respective treatment group. Six (6) wounds were assigned to each treatment group.
- Coblation wounds were surgically debrided with the device at default setting of 7 (photo f).
- Surgical Debridement wounds were debrided with a cold steel curette (photo g).
- No Debridement wounds were only covered with a polyurethane film dressing (photo h).



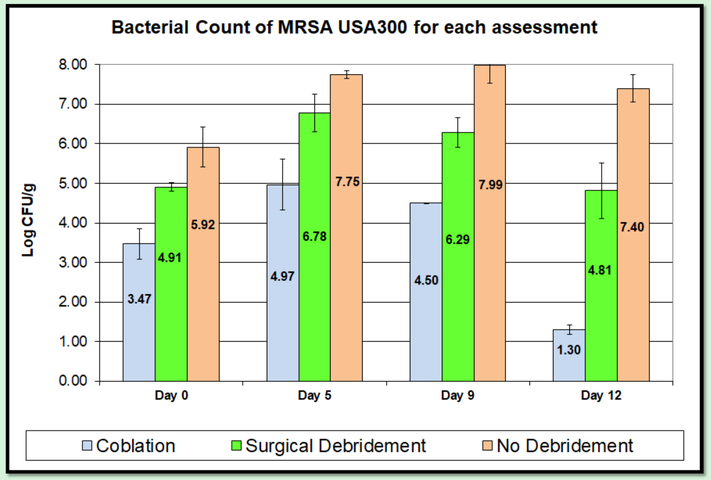
6. Microbiology Assessment:

- On days 0, 5, 9 and 12 post treatment, three wounds per treatment group were recovered by using a 6mm punch biopsy for microbiology analysis (photo i).
- Biopsies were weighed and then homogenized (Wheaton Tissue Grinder) with sterile Cold Phosphate Buffered Saline (PBS).
- Serial dilutions were prepared from these samples (photo j).
- Dilutions were quantified using the Spiral Plater System (which deposits a defined amount (50µL) of suspension over the surface of a rotating agar plate (photo k).
- MRSA USA300 was isolated on ORSAB (Oxacillin Resistance Screening Agar Base) plates and incubated at 37±2°C for 36-48 hours (photo l).
- The colony forming units per gram (CFU/g) were calculated and analyzed.



Results:

- On Day 0 after 24-hour biofilm formation, coblation treated wounds had a bacterial count that was 1.44±0.27 Log CFU/g (96.38% reduction) lower than Surgical Debridement wounds and 2.45±0.11 Log CFU/g (99.65% reduction) lower than No Debridement wounds.
- The Coblation MRSA burden compared to Surgical Debridement and No Debridement on Day 5 were decreases of 1.81±0.17 and 2.78±0.54 Log CFU/g (98.46% and 99.84% reductions), respectively.
- At Day 9, Coblation treated wounds showed reduced bacterial loads of 1.79±0.36 and 3.49±0.44 Log CFU/g (98.37% and 99.97% reductions) compared to Surgical Debridement and No Debridement wounds, respectively. Surgical Debridement wounds exhibited a bacterial reduction of 98.04% (1.71±0.07 Log CFU/g) when compared to No Debridement.
- The highest bacterial reduction of 99.99% (6.10±0.22 Log CFU/g) was observed on Day 12 with Coblation wounds compared to No Debridement wounds and 3.51±0.58 Log CFU/g (99.97% reduction) lower than Surgical Debridement wounds. A difference of 2.59±0.35 Log CFU/g (99.74% bacterial reduction) was revealed when comparing the Surgical Debridement to No Debridement wounds.
- Additionally, over the 12-day study period, a MRSA reduction of 3.67±0.52 Log CFU/g was observed comparing coblation treatment from Day 5 to Day 12 after treatment application.



Conclusions

- Coblation has a greater effectiveness than surgical debridement in reducing the bacterial burden in MRSA infections of wounds containing shrapnel.
- The ability of coblation to eliminate pathogenic organisms while precisely removing targeted tissue has important implications, especially for military personnel.
- Further studies of coblation and its effect on wound healing is warranted.

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