White Paper

Microwave Tissue Soldering for Immediate Wound Closure

Wounds can be closed rapidly, without staples, sutures, or tapes. Also a better option to Laser Wound Closure!

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A novel approach for the immediate sealing of traumatic wounds is under development by Meridian Health Systems, Inc., dba **Vascular Medicine Institute of America** in collaboration with scientists and engineers in the **Human Health and Performance** and **Engineering Directorates** at **NASA Johnson Space Center**, under a reimbursable Space Act Agreement. A miniaturized microwave generator and a handheld antenna are used to deliver microwave energy to a biodegradable protein solder, which is applied to the edges of the wound for sealing purposes. This method could be used for repairing wounds in emergency settings, by restoring the wound surface to its original strength within minutes. This technique could also be utilized for surgical purposes involving solid visceral organs (i.e., liver, spleen, and kidney) that currently do not respond well to ordinary surgical procedures.

The antenna can be of several alternative designs optimized for placement either in contact with or proximity to the protein solder covering the wound. In either case, optimization of the design includes the matching of impedances to maximize the energy delivered to the protein solder and wound at a chosen frequency. For certain applications, an antenna will be designed that would emit power only when it is in direct contact with the wound.

The optimum frequency or frequencies for a specific application would depend on the required depth of penetration of the microwave energy. In fact, a computational simulation for each specific application could be performed, which would then match the characteristics of the antenna with the protein solder and tissue to best effect wound closure.

Continuous microwave (CM) has already been shown to be effective in treating various pathologic states. The results of recent controlled clinical trial suggest that low-intensity continuous microwave is an effective postoperative treatment of purulent wounds after abdominal surgery. Thus, this may be an efficient method for simultaneously sterilizing and closing wounds.

Using microwave energy to seal wounds has a number of advantages over lasers, which are currently in experimental use in some hospitals. Laser tissue welding is unsuitable for emergency use because its large, bulky equipment cannot be easily moved between operating rooms, let alone relocated to field sites where emergencies often occur. In addition, this approach is highly dependent on the uniformity and thickness of the protein solder as well as the surgeon's skills. In contrast, the use of microwave energy is highly tolerant of the thickness of the protein solder, level of fluids in and around the wound, and other parameters that can adversely affect the outcome of laser welding. However, controlling the depth of penetration of the microwave energy into the wound is critical for achieving effective wound sealing without damaging the adjacent tissue. In addition, microspheres that encapsulate metallic cores could also be incorporated into the protein solder to further control the depth of penetration of the microwave energy.

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