Electrosurgical Plasma-mediated Ablation for Application in Dermal Wound and Cartilage Debridement - Biochemical, Microbiological and Clinical Effects

Akademisk avhandling

som för avläggande av medicine doktorsexamen vid Sahlgrenska Akademin, Göteborgs universitet, kommer att offentligen försvaras i sal Lyktan, Wallenbergs konferenscentrum, Medicinaregatan 20A, fredagen den 12 juni 2015 kl. 9:00

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Avhandlingen baseras på följande arbeten:


V. Sönnergren HH, Polesie S, Faergemann J. Coblation debridement of chronic venous ulcers – A single center, single arm, non-comparative prospective clinical case series. Manuscript
Electrosurgical Plasma-mediated Ablation for Application in Dermal Wound and Cartilage Debridement
- Biochemical, Microbiological and Clinical Effects

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ABSTRACT
The state of matter known as plasma has in the latest decades been investigated within different areas of medical treatment. The work presented in this thesis has focused on a specific type of plasma-based electrosurgical treatment modality (Coblation®) and its biochemical, microbiological and clinical effects on treatment of cartilage and dermal wounds.

Paper I investigated the biochemical effects of plasma ablation exposure of human articular chondrocytes in vitro. The plasma ablation induced a well-defined area of immediate cell death, an increased chondrocyte proliferation and up-regulation of cytokines IL-6 and IL-8. Paper II investigated the in vitro antimicrobial effect of plasma ablation on Staphylococcus aureus, Streptococcus pyogenes, Pseudomonas aeruginosa, Escherichia coli and Candida albicans. The plasma ablation had a direct microbial effect on all strains compared to untreated control and a temperature control. Papers III and IV investigated the bacteria aerosol formation and wound bacteria reduction of debridement using curette, plasma ablation or hydrodebridement in an ex vivo porcine wound model inoculated with S. aureus. Plasma ablation significantly reduced the wound bacterial load, while curette and hydrodebridement resulted in minor or no reduction. Hydrodebridement gave a significant bacterial spread to the operative environment, while plasma ablation and curette debridement did not. Paper IV also used scanning electron microscopy to detect if there was a bacterial biofilm in the porcine wound model. Paper V investigated the effect of debridement using plasma ablation on ulcer healing, wound bacteria colonization, and complications to the treatment, in a clinical case series of 10 patients with venous ulcers. The procedure was fast and easy to perform and gave a clean wound bed. The wound area was significantly reduced with a mean of 44 % and 2 of 17 ulcers healed within 8 weeks. The wound bacterial load was reduced by treatment with 1.5 log CFU/ml.

In conclusion, plasma ablation has a direct biochemical effect on chondrocytes indicating an onset of a tissue regeneration response. Plasma ablation can clinically be used for debridement of small ulcers in local anaesthesia. The bactericidal effect seen in vitro and ex vivo was confirmed clinically, which could be of value for the wound healing process. Further clinical studies should evaluate the plasma ablation method for use in other areas, such as in wound debridement prior to skin transplantation, diabetic foot ulcers, and burns.

Keywords: Ablation techniques, aerosol, antibacterial, arthroscopy, bacterial spread, bactericidal, bipolar radiofrequency, Candida albicans, cartilage, Coblation, debridement, electrosurgery, Escherichia coli, hydrosurgery, plume, Pseudomonas aeruginosa, Staphylococcus aureus, Streptococcus pyogenes

ISBN: 978-91-628-9390-3 (tryckt)
ISBN: 978-91-628-9391-0 (e-pub)