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

Akademisk avhandling

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av

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Läkare

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Avhandlingen baseras på följande arbeten:

I. Enochson L, Sönnergren HH, Mandalia VI, Lindahl A. Bipolar radiofrequency plasma ablation induces proliferation and alters cytokine expression in human articular cartilage chondrocytes. *Arthroscopy. 2012 Sep;28(9):1275-82*

II. Sönnergren HH, Strömbeck L, Faergemann J. Antimicrobial effects of plasma-mediated bipolar radiofrequency ablation on bacteria and fungi relevant for wound infection. *Acta Derm Venereol. 2012 Jan;92(1):29-33*

III. Sönnergren HH, Strömbeck L, Aldenborg F, Faergemann J. Aerosolized spread of bacteria and reduction of bacterial wound contamination with three different methods of surgical wound debridement: a pilot study. *J Hosp Infect. 2013 Oct;85(2):112-7*

IV. Sönnergren HH, Polesie S, Strömbeck L, Aldenborg F, Johansson BR, Faergemann J. Bacteria aerosol spread and wound bacteria reduction with different methods for wound debridement in an animal model. *Acta Derm Venereol. 2015 Mar;95(2):272-7*

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*

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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 of 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 microbicidal 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, Staphyloccus aureus, Streptococcus pyogenes

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