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Adjunctive Cold Plasma Therapy in Chronic Wounds: Accelerating Healing and Reducing Infection

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ABSTRACT

Introduction: Chronic wounds—especially diabetic foot, venous, and pressure ulcers—pose a major global challenge. These wounds are marked by persistent infection, biofilm formation, impaired tissue regeneration, and reduced quality of life. Poor perfusion and rising antimicrobial resistance often limit the effectiveness of standard debridement and wound care strategies. Cold atmospheric plasma (CAP) has emerged as a promising adjunctive treatment due to its antibacterial and antibiofilm activity. It can also modulate wound pH and stimulate granulation tissue without harming healthy cells. Reactive oxygen and nitrogen species target multiple microbial and inflammatory pathways, enhancing wound bed preparation and healing. Strategies controlling infection and inflammation are essential for chronic wound management.

Materials and Methods: This systematic review surveyed articles from ScienceDirect, PubMed, and Scopus between 2010 and 2025 using the keywords “cold atmospheric plasma”, “chronic wounds”, “debridement”, and “biofilm”.

Results and Discussion: CAP consistently accelerated wound closure, reduced wound area, and improved healing progression. It provided faster pain relief and sustained decrease in wound pH, creating a favorable antimicrobial environment. CAP disrupted biofilms, including those formed by Methicillin-resistant *Staphylococcus aureus* and *Pseudomonas aeruginosa*, while preserving healthy fibroblasts and keratinocytes. It also promoted proliferation, migration, angiogenesis, and granulation tissue formation. Furthermore, NRF2-mediated antioxidant pathways enhanced control of chronic inflammation. CAP demonstrated meaningful antimicrobial and regenerative benefits with minimal adverse effects.

Conclusion: CAP is a safe and promising treatment tool enhancing healing through pH modulation, microbial reduction, and tissue repair stimulation. Future research should optimize treatment parameters and standardize protocols to enable wider clinical adoption in chronic wound care.



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Keywords: Biofilm, Chronic wounds, Cold atmospheric plasma, Debridement, Diabetic foot ulcer

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