DECEMBER 11-12,2025
۲۱ و ۲۰ آذر ماه ۱۴۰۴
دومین کنگره پلاسما پزشکی ایران
The 2nd Congress on Plasma Medicine
دبیرخانه دائمی کنگره پلاسما پزشکی ایران
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Plasma-Induced Wound Conditioning Prior to Surgical Procedures: Preclinical Insights

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OPEN ACCESS

Citation:
Rajabi E, Nazari MJ. Plasma-Induced Wound Conditioning Prior to Surgical Procedures: Preclinical Insights. *Iran Biomed J.* Supplementary (2-2026): 18.

ABSTRACT

Introduction: This review synthesizes preclinical evidence on the use of cold atmospheric plasma (CAP) to optimize wound beds before surgery. It focused on the biological, antimicrobial, and regenerative effects of plasma-induced wound conditioning as observed in various experimental models.

Materials and Methods: A systematic search was conducted across PubMed, Scopus, Embase, Web of Science, and IEEE Xplore for relevant publications with no time limit until 2025. The inclusion criteria were: (1) in vivo or in vitro preclinical studies; (2) studies reporting outcomes related to microbial burden, tissue regeneration, perfusion, or inflammation modulation, and (3) studies featuring controlled experimental designs. Exclusion criteria were reviews, clinical trials, studies without control groups, or those not focused on pre-surgical conditioning.

Results and Discussion: A total of 22 studies involving 289 animals and over 900 wound samples met the inclusion criteria. CAP exposure consistently enhanced the quality of the wound bed prior to surgical closure. In 15 studies, microbial load decreased by 1.8-4.5 log10 colony-forming unit (95% CI: 1.6-4.8), favoring CAP-treated wounds. Furthermore, 10 studies demonstrated improved tissue perfusion, with a 12%-31% increase in microvascular flow (95% CI: 9%-34%). Anti-inflammatory effects were reported in 14 studies, showing reduced pro-inflammatory cytokines ranging from 22% to 55% (95% CI: 18%-58%). Enhanced collagen deposition and accelerated re-epithelialization were observed in nine studies, resulting in faster wound readiness for surgical intervention.

Conclusion: Preclinical evidence shows that plasma-induced wound conditioning improves sterility, perfusion, and inflammation control, suggesting that CAP could serve as a promising preoperative tool. However, the variability in experimental parameters limits comparability, highlighting the need for standardized protocols and further translational research.

Keywords: Plasma, Preclinical, Procedures, Surgical, Wound

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