

Realtime Measurements for Closed-Loop Control and Plasma Endpoint Detection for Wound Healing

The transient application of cold atmospheric pressure plasma (CAP) exposes cells to reactive oxygen and nitrogen species (RONS) which changes the redox status of cells immediately. However, several biological changes occur hours or days later. Therefore, it is difficult to establish relationships between applied doses and CAP effectors with biological outcomes and CAP dosing remains empirical. We used a cell model and a mouse model of wound repair to identify correlations between CAP effectors, early, intermediate and late molecular changes and their role in promoting healing. We used sub-optimal (no therapeutic benefit), optimal (improved wound repair as compared to untreated controls), and excessive (damage and poor wound repair) doses of CAP for each model. We used electrochemical wire sensors to monitor in situ two effectors in CAP, hydrogen peroxide (H₂O₂), and nitric oxide (NO). The immediate biological response to the different doses of CAP was determined by measuring calcium (Ca²⁺) release in the tissue culture fluid and wound bed. Oxidation-reduction potential (ORP) served as a combined indicator of CAP processes and biological responses. These sensor measurements were used to identify the threshold value of each, and a control scheme was developed to automatically terminate treatment once the desired concentration is reached. These studies lay the foundation for development of standardized treatment protocols.

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