

Investigation of the efficacy of dielectric barrier discharge jets (DBD-Jet) and plasma activated water (PAW) in wound treatment: an in-vivo study

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Introduction: The effects of cold plasma, such as antimicrobial, anti-inflammatory, tissue regeneration, cell proliferation, and angiogenesis have made this technology a therapeutic option for wound healing [1]. These effects not only are related to the treatment duration and type of tissue but also depend on the plasma configuration, working gas, and plasma source distance.

The dielectric barrier discharge jet (DBD-Jet) is a special type of plasma jet that guarantees the safety of the treatment. While using a ring electrode in this configuration weakens the discharge inside the dielectric tube [2], it led us to investigate the effectiveness of DBD-Jet on wound healing in direct and indirect methods.

Material and method: DBD-Jet was developed by the Plasma Technology Development Company (Tehran, Iran). In this study, the electrode is connected to an AC power supply ($V_{pp}=12$ kV, $f=55$ kHz), the helium gas rate flow is kept at 5 l/min. The plasma-activated water is prepared by applying the plasma jet on the surface of 2ml distilled water for 2 to 4 minutes.

The rats were randomly divided into 4 groups ($n = 6$): a wound without treatment (control), a wound treated with DBD-Jet plasma for 2 minutes (wound + DBD-Jet plasma), a wound treated with 2-minute plasma-activated water (wound + 2 min PAW), and a wound treated with 4-minute plasma-activated water (wound + 4 min PAW). The protocol is summarized in Fig. 1. A thermal camera (Testo 881) was used to measure the wound temperature during the plasmatherapy. The appearance of wounds was recorded using a Canon camera and pictures were analyzed with Image J (version 1.8.0). The variation of wound microbial load and histopathology was investigated.

Conclusion: We found that DBD-Jet plasma and rinsing of wounds by PAW can support wound healing and tissue regeneration. Interestingly, our results showed that the 2-minute PAW has proved to have more effectiveness in wound healing compared to the 4-minute one.

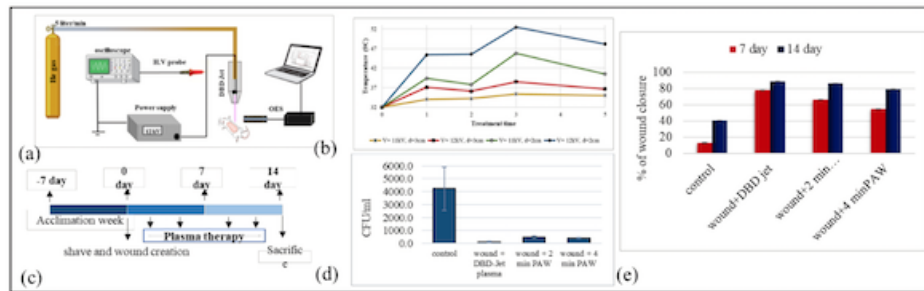


Fig. 1. (a) Plasma jet device, (b) plasma temperature vs treatment time, (c) Experimental Procedure (d) microbial load of the wound, (e) Rate of wound closure

Figure 1: (a) Plasma jet device, (b) Plasma temperature vs. treatment time, (c) Experimental Procedure (d) Microbial load of the wound, (e) Rate of wound closure.

References

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