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Comparison of Performance and Shelf Life of Floating Electrode Dielectric Barrier Discharge (FEDBD) and Plasma Spark on Hand Skin Rejuvenation

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ABSTRACT

Introduction: Cold atmospheric plasma (CAP) is emerging as a significant tool in dermatology, leveraging reactive oxygen and nitrogen species (RONS) to enhance microcirculation, oxygenation, and collagen synthesis without thermal injury, thereby promoting skin regeneration. The biological outcomes of CAP are modality-dependent. Two prevalent non-thermal systems are the spark plasma device (dot mode) and the plasma shower (FEDBD), used for both aesthetic and therapeutic applications, given the lack of comparative data on their tissue-level impact. This study aimed to precisely evaluate and contrast the effects of these two distinct plasma delivery systems on critical skin physiological parameters, specifically including tissue oxygenation (StO_2), perfusion (NIR), hemoglobin concentration (THI), and surface moisture (TWI).

Materials and Methods: Hyperspectral imaging (TIVITA® Tissue) was used to assess tissue oxygenation (StO_2), perfusion (NIR), hemoglobin (THI), and skin moisture (TWI) following cold plasma treatment. Two plasma devices—Spark Plasma (dot mode) and Plasma Shower (FEDBD)—were applied to the hand skin of 13 participants, and parameters were measured at four-time intervals.

Results and Discussion: Both plasma devices significantly improved skin physiology. Spark plasma (dot mode) showed greater enhancement in oxygenation and perfusion, indicating deeper tissue stimulation via higher ROS/RNS generation. Plasma shower induced milder but consistent improvements, mainly in hydration and hemoglobin levels, highlighting its gentler, surface-focused regenerative mechanism.

Conclusion: Spark plasma demonstrated superior and longer-lasting effects on skin oxygenation and perfusion compared to the plasma shower, likely due to its higher reactive species generation and deeper tissue interaction. Both methods proved effective, suggesting their complementary potential in noninvasive skin rejuvenation and clinical plasma-based dermatology applications.

Keywords: Hyperspectral imaging, Plasma shower, Plasma spark, Plasma therapy, Skin rejuvenation

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