Delivery of Oxygen to a Liquid Medium by a Novel Oxygen Delivery Device

Suleman, L., Thomas, H. and Westgate, S., J.

Introduction

Oxygen is a key component of wound healing. Creating an oxygen rich environment in wounds can increase ATP production, cell proliferation and collagen deposition; all of which promotes wound healing. Oxygen within the skin tissue also promotes the phagocytosis of bacterial infection by white blood cells, and the increased production of reactive oxygen species drives cell signalling for the angiogenesis of new blood vessels.

Novel technologies, such as Oxygen Delivery Devices* (Figure 1), aim to facilitate chronic wound healing by creating oxygen-rich environments. Due to the high levels of wound exudate, determining levels of oxygen transmission into liquids may determine the capabilities of supplementary oxygen to enter the wound.

Aim

To assess the levels at which a novel Oxygen Delivery Device* is able to deliver oxygen into air and liquid mediums; and to determine the effect of the device on cellular cytotoxicity.

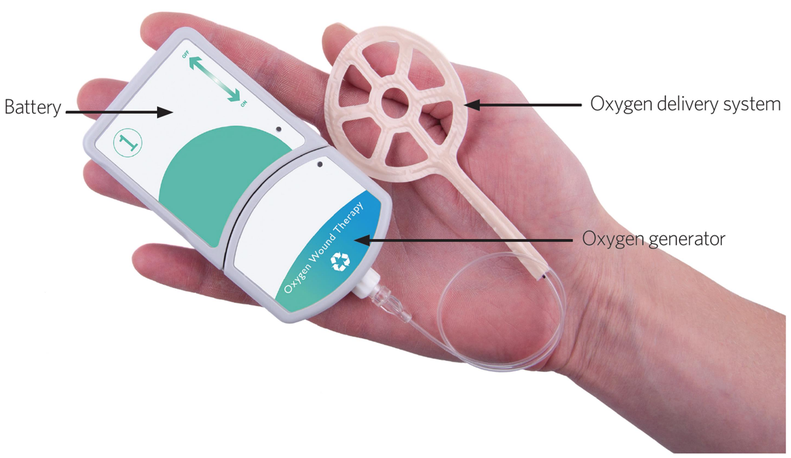

Figure 1. Photograph of Oxygen delivery system with Oxygen Generator.

Method

Oxygen Delivery Devices* were connected to sealed flasks containing no medium or tissue culture medium. Oxygen levels produced by the device and the level transferred into liquid was measured over 24 hours and 72 hours respectively using a Mettler Toledo Seven2Go oxygen-sensing monitor then compared to zero-hour readings. Testing was performed in triplicate.

Cytotoxicity of the oxygen levels produced were determined by treating 50% confluent human dermal fibroblasts with the Oxygen Delivery Device* for 48 hours and cell viability was assessed using MTT viability reagent.

Results

Following treatment of 1, 3, 5 and 24 hours with the device, oxygen levels in the empty vessel increased by 11.56%, 36.58%, 59.97% and 198.32% respectively (Table 1, Figure 2). Following treatment of 24, 48 and 72 hours with the device, oxygen levels in the liquid media increased by 200.85%, 259.50% and 291.47%, respectively (Table 2, Figure 3). The increased oxygen levels had no effect on cellular proliferation/viability when compared to the negative control with healthy appearance of cells at 48 hours (Figure 4).

Time (Hours)	Average oxygen increase within the flask (% ± SD)
0	0.00 ± 0.00
1	11.56 ± 0.14
3	36.58 ± 0.18
5	59.97 ± 0.10
24	198.32 ± 0.05

Table 1. Average increase in oxygen production in a T75 tissue culture flask, compared to zero-hour. SD = standard deviation. Measurements were taken in triplicate.

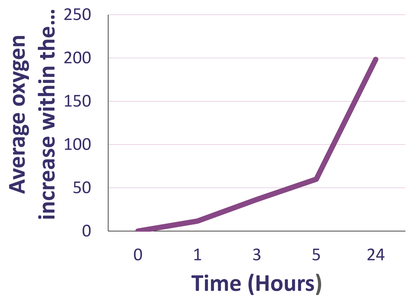

Figure 2. Average percentage increase in oxygen from the Oxygen Delivery Device* in a T75 tissue culture flask, compared to zero-hour. Measurements were taken in triplicate.

Time (Hours)	Average oxygen within liquid media (% ± SD)
0	0.00 ± 0.00
24	200.85 ± 0.70
48	259.50 ± 1.37
72	291.47 ± 0.27

Table 2. Average increase in oxygen in the liquid culture medium, compared to zero-hour (37°C ± 2°C and 5% CO_2). SD = standard deviation. Measurements were taken in triplicate.

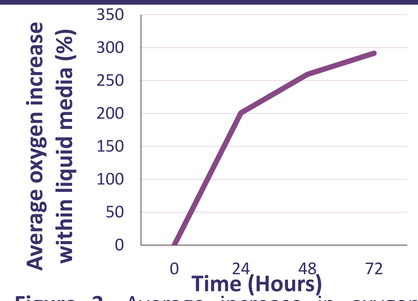

Figure 3. Average increase in oxygen production from the Oxygen Delivery Device* in the liquid culture medium, compared to zero-hour (37°C ± 2°C and 5% CO_2). Measurements were taken in triplicate.

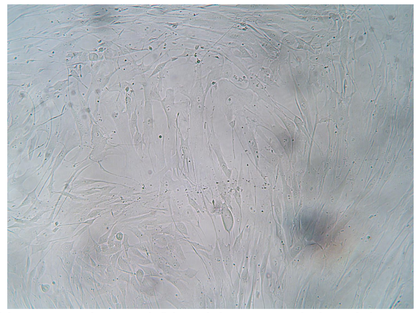

Figure 4. Image of human dermal fibroblasts with healthy appearance following 48 hours of treatment with Oxygen Delivery Device*.

Discussion & Conclusion

The introduction of sustained oxygen at the wound site has been shown to be beneficial for patients with non-healing wounds. In this test model, the Oxygen Delivery Device* demonstrated an increased delivery of oxygen into empty sealed flasks, and sealed flasks containing liquid medium. In addition, the level of oxygen produced was not cytotoxic to primary human cells. This suggested that the Oxygen Delivery Device* may be able to deliver oxygen to the exudate-rich layer of complicated wounds without causing tissue toxicity. This would need to be confirmed using further *in vitro* studies or clinical assessments.

References

Stücker, M. 2002. The cutaneous uptake of atmospheric oxygen contributes significantly to oxygen supply of human dermis and epidermis. Journal of Physiology. Volume 538 Issue 3: 985-94.

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Perfectus Biomed is an independent testing laboratory. Techspace one, Keckwick Lane, Cheshire, WA4 4AB. Tel +441925 737 237,
E-mail info@perfectusbiomed.com

*NATROX® Oxygen Delivery Device