

Low-energy laser irradiation influences tissue oxygenation in diabetic foot ulcers

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Background and aims: Impaired blood supply and tissue hypoxia adversely affect diabetic foot ulcer healing. Beneficial effects of irradiation with low-energy laser beam on wound healing have been demonstrated in clinical studies. We sought to investigate whether low energy laser irradiation exerts a favourable influence on tissue oxygenation. **Patients and methods:** 12 patients with diabetes mellitus (11 type 1, 1 type 2, average age 62.3 ± 10.2 years, HbA1c 8.97 ± 1.11 %, ankle/brachial index 1.18 ± 0.25) with chronic foot ulceration (area 4.0 ± 4.9 cm²) were included in the study.

Transcutaneous oxygen tension in the ulcerated site was recorded for 30 minutes at baseline and after 5 sessions of pulsatile laser irradiation, frequency 4 Hz, power density 4 J/cm² (portable BTL – 2000 laser therapy device, power 100 mW, wavelength 830 nm) which were performed at two-day intervals. A novel technique (Whitland Research SO₂ monitor) was used, which measures oxygen saturation remotely, non-invasively and is insensitive to patient movement. Spectral analysis by wavelet transform was applied to the oxygen saturation signal. Characteristic frequency peaks were identified: 0.005–0.0095Hz and 0.0095–0.021Hz, both reflecting endothelial activity; 0.021–0.052Hz, influenced by sympathetic nerve activity; 0.052–0.145Hz, reflecting myogenic activity; 0.145–0.6Hz, synchronous with respiration; and 0.6–1.6Hz, synchronous with heart rate. **Results:** After a single session no statistically significant difference was observed neither in the average value of tissue oxygen tension nor in any of its oscillatory components. After five sessions of laser irradiation however, the normalized spectral amplitude of tissue oxygenation signal was significantly higher than at baseline at frequency interval 0.052–0.145Hz (P=0.0183) and significantly lower at interval 0.145–0.6Hz (P=0.0265).

Conclusion: Our results indicate that long-term laser irradiation exerts a significant influence on tissue oxygenation in diabetic foot ulcers. Spectral analysis of the tissue oxygenation time series reveals increased influence of sympathetic nerve activity together with diminished influence of respiration related oscillations.