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HYPERSPECTRAL IMAGING IN HYPERBARIC OXYGEN THERAPY

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Abstract

Introduction. Hyperbaric oxygen therapy is a medical treatment that uses high concentrations of pure oxygen, at pressures exceeding 2 ATA (absolute technical atmosphere) for therapeutic purposes. The effects induced by this therapeutical modality at tissular levels are usually monitored using various methods, such as: transcutaneous oximetry, thermal imaging, planimetry or magnetic resonance imaging. However, new non-invasive methods with real-time applications are still required for a more accurate evaluation of its effects. In this study, the potential of an emerging medical hyperspectral imaging method to assess the effects of hyperbaric oxygen therapy on femoral head necrosis was evaluated.

Materials and methods. A 35-year-old female patient diagnosed with femoral head necrosis was included in this preliminary study. The patient received hyperbaric oxygen therapy inside a hyperbaric chamber at an oxygen pressure of 2.4 absolute atmospheres for 90 min, in three stages of 30 min each, separated by two breaks of 5 min breathing ambient air. A pushbroom hyperspectral imaging system was used to acquire the hyperspectral images of the foot before and after hyperbaric oxygen treatment. An algorithm based on the modified Beer-Lambert law and the Levenberg-Marquardt nonlinear least squares analysis method was used to generate, from the hyperspectral data, the distribution maps of oxyhemoglobin and deoxyhemoglobin concentrations, total hemoglobin and oxygen saturation across the investigated area that allow an easier and faster interpretation of the immediate effects of hyperbaric oxygen therapy.

Results. The results demonstrated the ability of hyperspectral imaging combined with an appropriate data analysis method to highlight the immediate effects of hyperbaric oxygen therapy. Increases in mean oxyhemoglobin concentration, total oxyhemoglobin, and oxygen saturation levels were recorded in the investigated area, while local deoxyhemoglobin levels decreased after tissue exposure to hyperbaric oxygen therapy, probably due to hyperoxic vasoconstriction.

Conclusions. In conclusion, hyperspectral imaging has proven to be a valuable tool for monitoring clinical evolution in various vascular diseases and could support physicians in making the right treatment decisions.