PubMed

Format: Abstract

Wound Repair Regen. 1999 Jan-Feb;7(1):53-64.

Effect of hyperbaric oxygen on human skin cells in culture and in human dermal and skin equivalents.

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Abstract

A critical stage of cutaneous wound healing is the development and maturation of the epidermis. In the aged, and in certain pathologies, this repair process is compromised due to a variety of deficiencies, one of which is tissue oxygenation. Several phases of wound healing are dependent on adequate tissue oxygen levels, and hyperbaric oxygenation has been shown to transiently elevate these levels. The use of human cell monolayers, dermal equivalents and human skin equivalents provide excellent opportunities for studying wound healing using in vivo relevant models. The goal of this study was to examine the effect of hyperbaric oxygen on cell proliferation, differentiation, and matrix biosynthesis in monolayer cultures and epidermopoiesis in the developing skin equivalent. Normal human dermal fibroblasts, keratinocytes and melanocytes, dermal equivalents and skin equivalents were exposed to hyperbaric oxygen at pressures up to three atmospheres, for up to 10 consecutive daily treatments lasting 90 minutes each. Increase in fibroblast proliferation (cf., 30% at 1 atmosphere after 10 days treatment), was observed without a significant effect on proliferation of normal human melanocytes and glycosaminoglycan synthesis. Stimulation of collagen synthesis after two days of treatment was only significant at 1 atmosphere (about 20% increase) but this differential was not observed after 5 days of treatment. Hyperbaric oxygenation above 2 atmospheres, inhibited proliferation of fibroblasts and keratinocytes in cell monolayer cultures (e.g., a 10 day treatment at 3 atmospheres appeared cytostatic to keratinocytes). In contrast, hyperbaric treatment up to 3 atmospheres dramatically enhanced keratinocyte differentiation, and epidermopoiesis in the complete human skin equivalent. These results support the importance of hyperbaric oxygen therapy in wound healing, and should provide an insight into oxygen utilization during repair of peripheral human tissue. The results also show the utility of the human skin equivalent as a model for evaluation of parameters involved in wound healing.

PMID: 10231506

[Indexed for MEDLINE]

Publication types, MeSH terms, Grant support