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ORIGINAL ARTICLE

Hyperbaric oxygen therapy reduces the severity of ischaemia, preservation and reperfusion injury in a rat model of liver transplantation

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Abstract

Background: Approaches to increase organ availability for orthotopic liver transplantation (OLT) often result in the procurement of marginal livers that are more susceptible to ischaemia, preservation and reperfusion injury (IPRI).

Methods: The effects of post-OLT hyperbaric oxygen (HBO) therapy on IPRI in a syngeneic rat OLT model were examined at various time-points. The effects of IPRI and HBO on hepatocyte necrosis, apoptosis, proliferation, and sinusoidal morphology and ultrastructure were assessed.

Results: Post-OLT HBO therapy significantly reduced the severity of IPRI; both apoptosis [at 12 h: 6.4 ± 0.4% in controls vs. 1.6 ± 0.7% in the HBO treatment group ($p < 0.001$); at 48 h: 2.4 ± 0.2% in controls vs. 0.4 ± 0.1% in the HBO treatment group ($p < 0.001$)] and necrosis [at 12 h: 18.7 ± 1.8% in controls vs. 2.4 ± 0.4% in the HBO treatment group ($p < 0.001$); at 48 h: 8.5 ± 1.3% in controls vs. 3.4 ± 0.9% in the HBO treatment group ($P = 0.019$)] were decreased. Serum alanine transaminase was reduced [at 12 h: 1068 ± 920 IU/l in controls vs. 370 ± 63 IU/l in the HBO treatment group ($P = 0.030$); at 48 h: 573 ± 261 IU/l in controls vs. 160 ± 10 IU/l in the HBO treatment group ($P = 0.029$)]. Treatment with HBO also promoted liver regeneration [proliferation at 12 h: 4.5 ± 0.1% in controls vs. 1.0 ± 0.3% in the HBO treatment group ($p < 0.001$); at 48 h: 8.6 ± 0.7% in controls vs. 2.9 ± 0.2% in the HBO treatment group ($p < 0.01$)] and improved sinusoidal diameter and microvascular density index.

Conclusions: Hyperbaric oxygen therapy has persistent positive effects post-OLT that may potentially transfer into clinical practice.

Keywords

ischaemia–reperfusion, transplant, resection, liver, transplant outcomes

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Introduction

Approximately 800 000 people die from end-stage liver disease around the world each year.[1] Orthotopic liver transplantation (OLT) is widely accepted as the definitive treatment in end-stage liver disease, selected liver malignancies and acute liver failure. The major limitation of liver transplantation is the availability of suitable donor organs. Increasing demand and rising mortality in patients awaiting transplantation have led to a number of techniques that increase the availability of donor organs.[2–5] However, these result in the procurement of organs with marginal functional capacity. Marginal donor organs are more susceptible to the effects of ischaemia, preservation and reperfusion injury (IPRI), which leads to an increased incidence of dysfunction and organ loss following transplantation.[6]

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