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Hydrogen gas inhalation during ex vivo lung perfusion of donor lungs recovered after cardiac death

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BACKGROUND

Ex vivo lung perfusion (EVLP) is a system that circulates normothermic perfusate into procured lungs, allowing for improved lung function and lung assessment. We investigated whether ventilation with hydrogen gas during EVLP improves the donation after cardiac death lung function and whether this effect persists after actual transplantation.

METHODS

Ten pigs were randomly divided into a control group (n = 5) and a hydrogen group (n = 5). No treatment was administered to induce warm ischemic injury for 1 hour after cardiac arrest, and EVLP was applied in procured lungs for 4 hours. During EVLP, the control group was given room air for respiration, and the hydrogen group was given 2% hydrogen gas. After EVLP, the left lung graft was orthotopically transplanted into the recipient and reperfused for 3 hours. During EVLP and reperfusion, the functional parameters and arterial blood gas analysis (ABGA) were measured every hour. Superoxide dismutase, heme oxygenase, interleukin (IL)-6, IL-10, tumor necrosis factor-α, and nucleotide-binding oligomerization domain-like receptor protein 3 were evaluated in lung tissue after reperfusion. Pathologic evaluations were performed, and the degree of apoptosis was evaluated. The wet/dry ratio was measured.

RESULTS

During EVLP and reperfusion, functional parameters and ABGA results were better in the hydrogen group. The expressions of superoxide dismutase ($p = 0.022$) and heme oxygenase-1 ($p = 0.047$) were significantly higher in the hydrogen group. The expressions of IL-6 ($p = 0.024$) and nucleotide-binding oligomerization domain-like receptor protein 3 ($p = 0.042$) were higher in the control group, but IL-10 ($p = 0.037$) was higher

in the hydrogen group. The lung injury severity score and the number of apoptotic cells were higher and the degree of pulmonary edema was more severe in the control group than in the hydrogen group.

CONCLUSIONS

Hydrogen gas inhalation during EVLP improved donation after cardiac death lung function via reduction of inflammation and apoptosis, and this effect persisted after LTx.

Section snippets

Methods

All surgical procedures and animal care in this study were performed in accordance with the Laboratory Animals Welfare Act, the Guide for the Care and Use of Laboratory Animals, and the Guidelines and Policies for Swine Survival Surgery provided by the Yonsei University Health System Institutional Animal Care and Use Committee.…

Lung function during EVLP

OC, a measurement of the oxygen transfer capacity of the lung, was not different between the 2 groups (Figure 1A). PVR, which increases as lung function deteriorates, was higher in the control group than in the hydrogen group over the entire duration of the EVLP, although the difference was not statistically significant (Figure 1B). The difference in lung compliance between the 2 groups was statistically significant ($p = 0.031$; Figure 1C). PAP was not different between the 2 groups over the…

Discussion

Use of DCD lungs is a good solution to manage the shortage of brain death donor lungs in LTx. Although the safety of LTx using DCD lungs has been repeatedly reported,[1] the relatively longer warm ischemic times of DCD lungs might deteriorate lung graft function. In this study, we demonstrated that hydrogen gas inhalation during EVLP in a pig DCD lung model improved DCD lung function by downregulating inflammatory and apoptotic markers, and this effect persisted after LTx.

EVLP maintains lung…

Disclosure statement

None of the authors has a financial relationship with a commercial entity that has an interest in the subject of the presented manuscript or other conflicts of interest to disclose.…

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> ...These results indicated the protective effects of the H2-rich preservation solution against lung I/R injury after prolonged cold ischemia in a canine orthotopic left LTx model. Since the report by Ohsawa and colleagues,5 H2 has been used as a therapeutic antioxidant for I/R injury attenuation and organ preservation in various medical fields.6-11,27-32 Our group previously reported the protective effects of an H2-rich preservation solution during cold ischemia in a rat LTx model....

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