

Acute exposure to C60 fullerene damages pulmonary mitochondrial function and mechanics

Dayene de Assis Fernandes Caldeira, Flávia Muniz Mesquita, Felipe Gomes Pinheiro, Dahienne Ferreira Oliveira, Luis Felipe Silva Oliveira, Jose Hamilton Matheus Nascimento, Christina Maeda Takiya, Leonardo Maciel & Walter Araujo Zin

Abstract

C60 fullerene (C60) nanoparticles, a nanomaterial widely used in technology, can offer risks to humans, overcome biological barriers, and deposit onto the lungs. However, data on its putative pulmonary burden are scanty. Recently, the C60 interaction with mitochondria has been described in vitro and in vivo. We hypothesized that C60 impairs lung mechanics and mitochondrial function. Thirty-five male BALB/c mice were randomly divided into two groups intratracheally instilled with vehicle (0.9% NaCl + 1% Tween 80, CTRL) or C60 (1.0 mg/kg, FUL). Twenty-four hours after exposure, 15 FUL and 8 CTRL mice were anesthetized, paralyzed, and mechanically ventilated for the determination of lung mechanics. After euthanasia, the lungs were removed en bloc at end-expiration for histological processing. Lung tissue elastance and viscance were augmented in FUL group. Increased inflammatory cell number, alveolar collapse, septal thickening, and pulmonary edema were detected. In other six FUL and six CTRL mice, mitochondria expressed reduction in state 1 respiration [FUL = 3.0 ± 1.14 vs. CTRL = 4.46 ± 0.9 (SEM) nmol O₂/min/mg protein, $p = 0.0210$], ATP production (FUL = 122.6 ± 18 vs. CTRL = 154.5 ± 14 μ mol/100 μ g protein, $p = 0.0340$), and higher oxygen consumption in state 4 [FUL = 12.56 ± 0.9 vs. CTRL = 8.26 ± 0.6], generation of reactive oxygen species (FUL 733.1 ± 169.32 vs. CTRL = 486.39 ± 73.1 nmol/100 μ g protein, $p = 0.0313$) and reason ROS/ATP [FUL = 8.73 ± 2.3 vs. CTRL = 2.99 ± 0.3]. In conclusion, exposure to fullerene C60 impaired pulmonary mechanics and mitochondrial function, increased ROS concentration, and decrease ATP production.

Keywords: Fullerene C60; Lung mechanics; Alveolar collapse; Mitochondrial function; ATP production; Reactive oxygen species