Angiogenesis in the brain after sevoflurane anesthesia in rats

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Background and Goal of study

- Although degeneration of brain cells including apoptosis has been demonstrated after inhalation of volatile anaesthetics in many reports, there is little information about the restoration process of the damaged cells after inhaled anesthesia.
- To approach the restoration process in the brain cells, we compared the ultrastructural changes in the brain cells just after sevoflurane anesthesia and those 7 days after sevoflurane anesthesia in rats.

Material and Methods

- We divided SD rats into three groups: the group just after sevoflurane (n=3), the group 7 days after sevoflurane (n=3) and the control group (n=3).
- Spontaneously breathing rats were anesthetized with 2% sevoflurane, 33% oxygen in nitrogen for 2 h in the group just after sevoflurane.
- Just after the end of anesthesia, the chest was opened through a median sternotomy under intraperitoneal (IP) pentobarbital anesthesia (100 mg/kg).
- A catheter was inserted through the apex of the left cardiac ventricle and advanced into the ascending aorta for infusion of 0.1 M cacodylate buffer (pH 7.4).
- The right atrium was inserted to drain the perfusion fluid. These were postfixed in 2% glutaraldehyde solution in 0.1 M cacodylate buffer (pH 7.4).
- The brain was removed and embedded in Epon, and ultrathin sections were made.
- These were stained with lead citrate and uranyl acetate and were observed in a transmission electron microscope (H-7650, HITACHI, Tokyo, Japan).
- The group seven days after sevoflurane and the control group were anesthetized with IP pentobarbital.
- The other treatments were the same as the group just after sevoflurane.

Results and Discussion

- In both of the sevoflurane groups, there were many degeneration cells with atrophic nuclei in both cerebral cortex and hippocampus.
- In the group 7 days after sevoflurane, many capillaries of a few micro-meter in diameter were found.
- Its endothelial cells had large nuclei, various rich organelle and small vascular cavity.
- The characteristics of these vessels were immature blood vessel (I).

- These vessels described above were not found in the just after sevoflurane and the control groups.
- These findings suggest that angiogenesis is induced in the restoration process of the degenerated brain cells after sevoflurane inhalation.

Neuronal cells

Control
(Cerebral cortex)

Just after sevoflurane
Degeneration cells
(Hippocampus)

7 days after sevoflurane
Degeneration cell
(Hippocampus)

Blood vessels

Control
(Cerebral cortex)

Just after sevoflurane
Degenerated perivascular cells
(Cerebral cortex)

7 days after sevoflurane
Degenerated perivascular cells
(Hippocampus)

7 days after sevoflurane
Immature blood vessel
(Cerebral cortex)

7 days after sevoflurane
Immature blood vessel
(Hippocampus)

Yellow parts are vascular cavity.

Conclusions

- We found many degeneration cells with atrophic nuclei and possible angiogenesis 7 days after sevoflurane anesthesia in the rat brain.
- Angiogenesis is likely to be induced in the restoration process of the degenerated brain cells caused by sevoflurane anesthesia.

Reference

(1) Hannah RS, et al. Anat Rec 178: 691-710, 1974.

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