Abstract

Changes in Cerebral Blood Flow and Brain Tissue Oxygen Tension during Normovolemic Hemodilution in Cryogenic Brain Injury of Rabbits

Fluid replacement after hemorrhage usually results in hemodilution. Hemodilution leads to increased cerebral blood flow, which is known to be beneficial to the outcome of ischemic brain damage. However, the effect of hemodilution may be different in patients with head injuries and increased intracranial pressure (ICP). The aim of this study is to evaluate the effects of normovolemic hemodilution on cerebral blood flow (CBF), brain tissue oxygen tension (PbtO₂), and severity of cryogenic brain injury, and to determine the acceptable limit of hemodilution during cryogenic brain injury.

Thirty New Zealand white rabbits were anesthetized with O₂-N₂O-isoflurane. Cryogenic brain injury (1 cm in diameter) was produced by applying liquid nitrogen on the surface of the right parietal bone for 90 seconds. Sixty minutes after cryogenic brain injury, acute normovolemic hemodilution was induced with 10% pentastarch for 30 minutes. In group I (n=7), hemodilution was not induced. In groups II (n=7), III (n=8), and IV (n=8), the hemoglobin concentrations were adjusted to 9-10, 6-7 and 3-4 g/dL, respectively. Mean arterial...
pressure, central venous pressure and ICP were measured. Local CBF and PbtO$_2$ of the right parietal subcortex were continuously measured. The rabbits were euthanized 150 minutes after brain injury, and the brains were removed and sectioned coronally through the center of the lesion. The extent of brain injury at the coronal plane was measured by light microscopic examination. The posterior part of the brain was divided into two halves and the water fraction of each part was measured by the dry-weight method. The data was compared with Kruskal–Wallis test or with repeated measures ANOVA. The difference was considered significant when $P < 0.05$.

There were no differences in mean arterial pressure, central venous pressure and rectal temperature. There were significant differences in ICP, CBF and PbtO$_2$ among groups. ICP was significantly higher in group IV when compared to groups I and II. The CBF values of groups III and IV were higher than those of group I. The values of PbtO$_2$ of group IV were lower than those of groups I and II. Normovolemic hemodilution of up to 6–7 g/dL of hemoglobin concentration led to an abrupt increase in CBF and a subsequent increase in ICP. Hemodilution of up to 3–4 g/dL of hemoglobin concentration decreased brain tissue oxygen tension significantly. There was no difference in the brain water fraction and the extent of cryogenic injury among groups.

It is concluded that the acceptable limit of acute normovolemic
hemodilution in cryogenic brain injury is 9–10 g/dL of hemoglobin concentration in that ICP and CBF do not increase and PbtO₂ is not deteriorated.

Key words : normovolemic hemodilution, cryogenic brain injury, cerebral blood flow, brain tissue oxygen tension

Student Number : 2000-31010