

## Symposium (K)

### *Hypothermia*

Chairman :

Prof. S. Katsura

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#### **K1. Hypothermia in Neurosurgical Aspect.**

—Especially, on the Various Problem in Relation  
to Interruption of Cerebral Circulation—

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General hypothermia to prevent anoxia during temporary occlusion of cerebral blood vessels allows a more satisfactory approach to vascular intracranial tumor, intracranial aneurysma and arteriovenous malformation.

The fundamental studies on the central nervous system in hypothermia and clinical experiences in past 4 years were reported.

Fundamental Study: Physiological responses of brain to hypothermia.

- 1) Cerebrospinal fluid pressure: Cerebrospinal fluid pressure fall progressively with hypothermia and that of normal brain dogs at 25°C reduced to 43.3% of 37°C in average. The rate of reduction for each degree centigrade was greater between 30°C-25°C.
- 2) Brain volume: Brain volume in normal dogs were reduced and represented an increase of 31.92% in the extracerebral space of cranial cavity. Reduction of brain volume in artificial brain swelling dogs were more remarkable.
- 3) Water content of the cerebral cortex: The water content of the cerebral cortex at 25°C, free water was reduced to 67.93% and this means hypothermia produced significant reduction of water content in the cerebral cortex. In cases with artificial increased intracranial pressure by ligation of jugular veins and insertion of paraffin intracerebrally, the reduction of free water of cerebral cortex were stronger in the former.
- 4) Cerebral oxygen consumption and cerebral metabolic rate: The reduction

of cerebral oxygen consumption at 25°C were 63.36% of that at normal temperature and cerebral metabolic rate at 30°C were reduced to 45.7% and at 25°C were 34.8%.

5) Arteriovenous oxygen difference: No significant changes of arteriovenous oxygen difference was observed in hypothermia and it would be caused by diminution of cerebral blood flow.

6) PH of cerebral tissues and carotid artery blood: The PH of cerebral cortex at 25°C showed slight diminution in activity but no significant changes of artery blood were observed under satisfactory ventilation.

7) Diameter of cortical vessels: Cortical vessels in dogs shows progressive reduction in calibre beginning at 32°C., with the most marked changes occurring in vessels of 200 m $\mu$ . and 45% reduction in artery size at 25°C and 25% reduction in vein were observed.

8) Temperature of various portion of body: The rectal temperature fall more rapidly than cortical temperature, especially in case of rapid cooling. During hypothermia the reduction of cortical temperature was more rapidly between 30°C-25°C.

On the Change by interruption of cerebral circulation.

1) Oxygen consumption after release of cerebral vessel occlusion: In cases of normothermic dogs oxygen consumption increased by interruption of 3 and 5 minutes but diminished below of normal level by 7 and 10 minutes. On the other hand increase of oxygen consumption in hypothermic dogs were very slight (3-5%) even by interruption of 10 minutes.

2) Arteriovenous oxygen difference: In normal temperature dogs arteriovenous oxygen difference decreased 38% by 5 minutes interruption and 50% by 10 minutes interruption. Hypothermic dogs shows only 4-9% decrease by 10 minutes interruption.

From above data on oxygen consumption and arteriovenous oxygen difference occlusion time under hypothermia is threefold of normal temperature.

3) The interval between each occlusion: Multiple periods of cerebral circulation occlusion are not tolerated unless the time between occlusion was progressively lengthened (more than 3 minutes) or occlusion time are reduced from measurement of arteriovenous oxygen difference and E E G.

On the problem of the thrombosis formation: Under hypothermia the blood pressure falls with probably decreased cardiac output, the viscosity was usually increased with the hemoconcentration and the increased hematocrit occurs with probably diminution of the whole plasma volume.

On the other hand, bleeding and clotting times were normally increased with the hypothermic state which is probably beneficial because with the slowing in blood circulation there should be an increase in the occurrence of the thrombosis, and the increased bleeding and clotting times act as effective mechanisms for probably counting this.

The above mentioned results were based on the hypothermic states, however in the rewarming period it is something different.

In our experiment the increased blood platelet counts and decreased bleeding and clotting times (Hypercoagulability) occur after getting normal body temperature and these condition persist for 2 hours, that is to say, this means that there should be increase in the occurrence of thrombosis within 2 hours after getting normal body temperature. From this stand of view rewarming must be carefully done with the moderate method, and it is needless to say that the mechanical damage of the arterial wall which is temporary occlusion should be avoided.

**Clinical Cases:** Intracranial operation under hypothermia has been utilized in 72 cases and in 33 cases of that interruption of common carotid and vertebral arteries was done during operation. 33 cases consists of 15 cases of cerebral vascular lesion (9 cases of aneurysm, 3 cases of arteriovenous malformation, 3 cases of hemangioma), 13 cases of vascularized brain tumor and 5 cases of hemispherectomy for cerebral hemiatrophy.

Surface cooling in a bath using crushed ice is preceded by isolation of the common carotid and vertebral arteries in the neck. The common carotid and vertebral arteries have been occluded immediately before application of clip to the aneurysmal neck or vessels and when severe hemorrhage developed.

The period of carotid and vertebral occlusion was 5-8 minutes at 26°-30°C in rectal temperature. Reduction of hemorrhage in the operative field by occlusion of carotid and vertebral arteries were divided into 4 groups, namely marked dry in 15 cases, moderate dry in 9 cases, relative dry in 6 cases and no effect in 3 cases.

From our opinion it appears that in human the maximum period of bilateral occlusion of carotid and vertebral arteries at 30°C should not exceed 6 minutes and at 27°-28°C should not exceed 18 minutes.

## K2. Electrical Activities of Neo-, Paleo- and Archicortical Systems Under Hypothermia.

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In order to clarify the mechanism of "cold narcosis", the changes of electrical activity levels of neo-, paleo- and archicortical systems, especially the hippocampal electrical activity with relation to the blood pressure under hypothermia were studied on unanesthetized curarized cats. Cats were cooled with ice water immersion.