SHORT COMMUNICATION

Intraoperative mild hypothermia therapy in patients scheduled for neurosurgical procedures

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Abstract

Background: **Deliberate mild hypothermia has been proposed as a means of providing cerebral protection during neurosurgicals procedures complicated by cerebral ischaemia. Our prospective study was designed to examine the safety of deliberate mild hypothermia and to evaluate our techniques for cooling and rewarming.**
Materials and methods: **With institutional approval, 20 patients scheduled for elective neurosurgery were enrolled into our prospective study. After the induction of anaesthesia, the core temperature was measured by urinary catheters with probes (Kendall). The patients were cooled (temperature of blankets set at 15 °C) and rewarmed (temperature set at 40 °C) by two circulating water blankets (Blanketrol III, Cincinnati Sub-Zero, Cinccinnati). The variables are expressed as a mean ± standard deviation.**
Results: **The time of anaesthesia was 316±53 min. The core temperature was 36.5±0.4 °C at the start of anaesthesia. The minimal temperature reached 34.4±0.4 °C. The patients were cooled at a rate of 1,1±0,3 °C/h and rewarmed at a rate of 0.9±0.4 °C/h. The temperature was 35.8±0.5 °C after the neurosurgical procedure. Deliberate mild hypothermia with rewarming did not cause delays in emerging from anaesthesia. On the control CT scan, no ischaemic changes were observed after surgery.**
Conclusions: **Our findings indicate that patients can be cooled and rewarmed by two circulating water blankets, and core temperatures about 34 °C were easily achieved. The deliberate mild hypothermia is together with careful anaesthesia management a safe technique of cerebral protection from ischaemic insult during elective neurosurgical procedures.** ***(Tab. 1, Ref. 11.)***
Key words: intraoperative mild hypothermia therapy, patients scheduled neurosurgical procedures.

Deliberate mild hypothermia has been proposed as a means of providing cerebral protection during neurosurgical procedures complicated by cerebral ischaemia, such as cerebral aneurysm clipping, arteriovenous malformations and supratentorial tumor resections (Smrcka,1998). Investigations in laboratory animals have demonstrated that mild hypothermia (2–4 °C temperature reduction) is associated with substantial decrease in histologic damage in models of both global and focal cerebral ischaemia (Busto, 1987; Kader, 1992; Smrcka, 1999). This prospective study was designed to examine the safety of deliberate mild hypothermia and to evaluate our techniques for cooling and rewarming by two circulating water blankets during neurosurgery. This technique of cerebral protection has not been routinely used in the Czech Republic so far.

Material and methods

With institutional approval, 20 patients scheduled for elective supratentorial tumour resection or aneurysm repair were enrolled into the study. Only patients operated in a supine position were included. All patients were premedicated with atropine 0.5 mg and promethazine 50 mg IM 45 min preoperatively. Ana-

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Tab. 1. Demographic variables.

Age (yr)	45±13
Sex (F/M)	11/9
Weight (kg)	73±10
Disease	
Cerebral aneurysm	4
Brain tumour	15
A-V malformation	1

esthesia was induced by thiopental 5 mg/kg, fentanyl 1–2 μg/kg and pancuronium 8 mg. The trachea was intubated, and the lungs were mechanically ventilated. Anaesthesia was maintained with 60 % nitrous oxide in oxygen, sevoflurane and supplemental dose of fentanyl and pancuronium. During anaesthesia, routine monitoring was used, including invasive blood pressure measurement. The core temperature was measured by urinary catheters with probes (Kendall). Circulating water blankets (Blanketrol III, Cincinnati Sub-Zero, Cinccinnati) were placed under the body and on the ventral body surface of each patient. After the induction of anaesthesia, the temperature of the water blankets were set up to 15 °C. Active cooling was stopped at a body temperature of 35 °C and the body temperature was allowed to drift downward. Temperature settings on both water blankets were then adjusted to maintain a target body temperature of 34 °C. After major surgical procedures, such as aneurysm clipping or tumour removal, rewarming was instituted with the water blankets set up to 40 °C. The variables are expressed as a mean±standard deviation.

Results

Demographic data are shown in Table 1. The time of anaesthesia was 316±53 min. 16 patients were extubated at the operating room, 4 patients (3 after aneurysm clipping and 1 after tumour resection) were transferred to the intensive care unit under mechanical ventilation. The core temperature was 36.5±0.4 °C at the start of anaesthesia. The minimal temperature reached 34.4±0.4 °C. The patients were cooled at a rate of 1.1±0.3 °C/h and rewarmed at a rate of 0.9±0.4 °C/h. The temperature was 35.8±0.5 °C after the neurosurgical procedure. Deliberate mild hypothermia with rewarming did not cause delays in emerging from anaesthesia. The time elapsing from the completion of the head wrap to tracheal extubation was 16±10 min. The estimated total blood loss was 460 170 ml and none of the patients obtained blood transfusion. On the control CT scan after surgery, no ischaemic changes were observed.

Discussion

The main goal of anaesthesia management of patients scheduled for intracranial vascular procedures and space-occupying lesions is to protect the brain from ischaemic insult by increasing the available oxygen supply and decreasing the oxygen demand (Smrcka, 1999). Hypothermia decreases both metabolic and functional activities of the brain and reduces $CMRO_2$ by 7 % for each degree Celsius. If the normothermic brain (37 °C) can tolerate 5 minutes of complete ischaemia, then at 27 °C, the brain should tolerate 10 minutes of ischaemia. However, a small decrease in temperature also resulted in significant reductions in the effects of cerebral ischaemia. The possible mechanisms include decreased calcium influx, decreased excitatory amino acid release, blood barrier preservation, prevention of lipid peroxidation, and limited extension of cytoskeletal damage (Dietrich, 2000). The current therapeutic recommendation is to achieve mild hypothermia (brain temperature of 32 °C to 35 °C) (Newfield and Cottrell, 1999).

The lowering of body temperature is associated with some adverse effects too. Cardiovascular system changes include bradycardia, prolongation of the PR and QT intervals, widening of QRS complex on ECG, as well as respiratory, metabolic changes and renal dysfunction. However, if the temperature is greater than 33 °C, physiological changes are generally minimal (Hinds and Watson, 1996).

Core hypothermia during general anaesthesia develops in three characteristic phases (Sessler, 1991). The initial core hypothermia results from redistribution of body heat from the core to the periphery while anaesthesia inhibits tonic thermoregulation vasoconstriction. Subsequently heat loss that exceeds metabolic heat production decreases the core temperature in a slow linear fashion. Finally, the core temperature plateau results when the resumption of thermoregulatory vasoconstriction decreases the cutaneous heat loss and constrains the metabolic heat to the core thermal compartment. Factors that affect the cooling rate include morphometric characteristics of patients, the presence or absence of vasoconstriction, and the method of cooling (Kurz, 1995).

In the presented study, we used a new technique of cooling by two circulating water blankets. The patients were cooled at a rate of 1.1±0.3 °C/h and rewarmed at a rate of 0.8±0.4 °C/h. These results are very similar to the study of Baker, in which the patients were cooled and rewarmed by combination of a water blanket and a convective device blanket (Baker, 1994). The minimal temperature reached was similar in both studies too (34.4±0.4 °C in our study compared to 34.3±0.4 in Baker et al study). In summary, our findings indicate that patients can be cooled and rewarmed by two circulating water blankets and core temperatures about 34 °C were easily achieved. A deliberate mild hypothermia is together with careful anaesthesia management a safe technique of cerebral protection from ischaemic insult during elective neurosurgical procedures.

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