

Prospective

Hypothermia of the brain - a prospective method for preventing the development of complications of sports craniocerebral injuries

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Cerebral brain injuries (CBIs) account for up to 20% of all injuries in boxing. Approximately 97% of sports-related brain injuries are mild, their neurological symptoms are unexpressed, and young, strong, highly motivated athletes tend to dismiss the severity of their injuries. This may lead to an underestimation of the severity and extent of brain injuries. Changes in computed tomography (CT) and magnetic resonance imaging (MRI) in mild traumatic brain injury are absent in the early stages, making diagnosis difficult. Frequent repetitive traumatic brain injuries, including mild brain injuries, can result in functional and structural brain lesions that affect athletes' performance and, in the long term, significantly impair their quality of life. Also, the consequences of cerebral brain injuries, including mild brain injury, can be affected by the individual condition of the Circle of Willis.

A sports trauma has specific features that significantly distinguish it from a domestic or criminal injury. During physical activity, hyperventilation and a decrease in partial carbon dioxide pressure in arterial blood (PSO₂) are accompanied by a decrease in cerebral perfusion due to the natural reactions of cerebral blood flow autoregulation. In addition, peripheral redistribution of blood flow in favor of the working muscles and skin develops due to increased heat generation and perspiration. In physical hyperthermia, loss of water and electrolytes increases the vulnerability of the brain. Fluid loss leads to an increase in dehydration. Together, these phenomena lead to a significant decrease in cerebral perfusion and oxygenation, forming "steal" syndrome and the brain during this period becomes particularly vulnerable to traumatic damage. Increased brain temperature together with reduced perfusion and oxygenation seems to account for the central mechanisms of fatigue, impaired speed, strength and coordination functions. Temperature increase in physical hyperthermia can lead to significant disorders of cerebral

More Information

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circulation even in cases where there is no primary brain damage and if present, it aggravates the pathological process. The insidiousness of mild sports traumatic events lies in the difficulty of early diagnosis of injury severity and the challenge of prognosis of its negative consequences, which cannot be predicted in this case. Also, there is a problem in absence of the technology for early rehabilitation and prevention of complications after a mild traumatic brain injury.

In studies of brain temperature fluctuations in traumatic brain injury the technology of non-invasive microwave radiothermometry (RTM) is used. RTM is based on recording the power of the tissue's own electromagnetic radiation in the microwave range (1-7 GHz) and is applicable for the evaluation of brain temperature estimation [1]. The measurement accuracy is $\pm 0.23^{\circ}\text{C}$ and allows to evaluate brain cortex temperature at 5-7 cm depth from the skin surface [2].

Immediately after receiving a sports mild traumatic brain injury, including those which are not accompanied by the neurological symptoms, focal cerebral hyperthermia develops with 38-40°C heat centers. The development of focal hyperthermia manifests the fact of trauma and indicates the development of post-traumatic inflammation, which may be the cause of future structural changes in the brain. RTM provides information about brain trauma before changes on CT and MRI.

As the temperature increase, cerebral perfusion and oxygenation decrease are the main pathogenetic mechanisms



of negative consequences of sports traumas, the technology of selective cortical hypothermia induction using craniocerebral hypothermia (CCH) seems promising.

With a scalp temperature of 5-7°C, the temperature of the brain cortex decreases by 2-2.5°C during 20-25 minutes of cooling, which is confirmed by the RTM measurements of the brain data. The procedure which lasts approximately 45-60 minutes normalizes the cortical temperature, and provides a decrease in general physical hyperthermia. In the case of neurological symptoms of trauma, it alleviates their manifestations [3]. Given the significant neuroprotective potential of therapeutic hypothermia, it seems very promising to use it to prevent the development of complications of mild sports traumatic brain injury. This implies that further research is needed.

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