INFLUENCE OF MAGNESIUM ON LOCAL CEREBRAL MICROCIRCULATION IN PATIENTS WITH SUBARACHNOID HEMORRHAGE: PRELIMINARY DATA USING AN INTRAOPERATIVE LASER-DOPPLER SPECTROPHOTOMETRY SYSTEM

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Background and Goal of Study:

The intravenous application of magnesium sulfate during neurosurgical procedures can foster vasodilatation, which is a desirable mechanism in vasospasm therapy especially in patients with subarachnoid hemorrhage (SAH). However, there are only few reports dealing with the impact of magnesium on local cerebral microcirculation in those patients. We present our preliminary results using a novel non-invasive, real-time measurement device during neurosurgical procedures.

Fig. 1: The elastic fiber optic O2C probe has a protective rubber coating. At the tip of the probe, white light and laser light is emitted. Backscattered light is registered by the detectors located at the proximal part of the probe. Reproduced with permission of LEA Medizintechnik GmbH, Germany.

Materials and Methods:

In this prospective, single-institution, non-randomized trial we studied local cerebral microcirculation using the non-invasive laser-Doppler spectrophotometry system „Oxygen-to-see (O2C)“ in 10 consecutive patients with aneurysmatic SAH Hunt and Hess grade 2 to 5 with aneurysms of the anterior and middle cerebral arteries. After dura opening, a probe (Fig. 1) was placed onto the cortex next to the site of preparation (Fig. 3).

In 7 mm tissue depth, capillary venous oxygenation (SO₂), post-capillary venous filling pressures (rHb), blood cell velocity (velo) and blood flow (flow) were measured. Data was recorded as baseline immediately before application of 5 g magnesium sulfate 10% and 10 minutes thereafter over a time period of 30 seconds. Magnesium sulfate was administered continuously with a infusion rate depending on blood pressure (>100 mmHg systolic) over a time period of max. 60 minutes.

Fig. 2: O2C-parameters during real-time monitoring. After application of magnesium sulfate, local cerebral perfusion shows a gradual increase in blood flow (green) and blood cell velocity (yellow). Post-capillary venous filling pressures (red) are decreased with no changes in capillary venous oxygenation (blue). Values are displayed in percent (%; left ordinate) or arbitrary units (AU; right ordinate) over time (hrs, min, sec; abscissa).

Fig. 3: Microscope view showing the operating field in a patient with SAH grade 2 (Hunt & Hess) caused by a ruptured aneurysm of the right anterior cerebral artery. The subdural probe is placed on the cortex of the middle temporal gyrus.

Results and Discussion:

We observed a higher median flow of 22% (4-70%) and velo of 9% (6-32%), no changes in SO₂, and a decrease of rHb of 7% (5-30%) compared to the baseline measurements. This indicates an increased cerebral blood flow on the microcirculatory level. Anesthesiological parameters remained stable with temperature corrected partial carbon dioxide pressure 37.8 ± 3.6 mmHg, hemoglobin 11.6 ± 1.6 g/dl, hydrogencarbonate 24 ± 1.1 mmol/l, positive endexpiratory pressure of 1 to 3 mBar, systolic/diastolic blood pressure of 102 ± 13.3 mmHg and 55 ± 8.9 mmHg, mean arterial blood pressure of 72.5 ± 10.1 mmHg, heart rate 56 ± 10.3 bpm, endexpiratory CO₂ of $31 \pm 2.4\%$, inspiratory O₂ of $45 \pm 7.8\%$, bladder temperature 35.8 ± 0.6 °C.

Conclusion:

Data indicate that local cerebral microcirculation is increased after intravenous application of magnesium sulfate in patients with aneurysmatic subarachnoid hemorrhage. Continuous real-time monitoring of brain perfusion parameters could possibly guide the rate, duration and concentration of magnesium sulfate to prevent vasospasm.

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