Cerebral protection in aortic surgery with deep hypothermic circulatory arrest
- Analysis of perioperative data –

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Background: In repairing of the ascending aortic arch there is a high risk that neurological complications could arise. Decisive factors in the neurological outcome are:

the existence of a preoperative adverse effect of the cerebral perfusion
the quality of the cerebral protection during the course of the operation

Therefore, the performance of the extracorporeal circuit (ECC) during the operative treatment of aortic aneurysms and aortic dissections requires the perfusionist to be highly competent and flexible. In addition, special ECC-equipment is necessary.

Materials and Methods: From 1/2004 -1/2006 twenty-five patients with deep hypothermic circulatory arrest (DHCA) in aortic surgery were operated on the University Hospital in Regensburg. All of them were provided with a selective antegrade cerebral perfusion (ACP). Measuring the pressure on the cerebral cannula gives an indication of forward flow.
The arterial cannulation of patients with an aortic dissection or an aortic aneurysm is in itself a great challenge. Possible approaches are firstly the subclavian artery, secondly the femoral artery, and thirdly the cannulation of the aorta ascendens at the ligamentum arteriosum Botalli [Table 1].

Aortic dissection [%]	Emergency [%]	Age [years]	Preoperative LCO [%]	ECC – time [min]	DHCA – time [min]	ACP-time [min]
68	68	58 ± 15	10	187 ± 62	48 ± 23	35 ± 21

Table 1.: Deep hypothermic circulatory arrest (DHCA) with antegrade cerebral perfusion (ACP) in aortic surgery,
LCO = low cardiac output

At the beginning of the perfusion, the water temperature of the ECC amounted to 15°C. After a prompt cooling with a tympanic temperature of 21,3 ± 2,4 °C (bladder temperature 25,6 ± 3,9°C, rectal temperature 28,2 ± 3,1°C) the circulatory arrest was started and the selective antegrade cerebral perfusion was installed. Monitoring the oxygen saturation during the cerebral perfusion with the near infrared spectroscopy (INVOS®, Somanetics Inc.) indicated the quality of the cerebral perfusion based on the ECC [Table 2] . In the course of the selective antegrade cerebral perfusion, this resulted in a mean pump flow of 239 ± 63 ml/min over the left carotid artery and 240 ± 68 ml/min over the right carotid artery.
Measuring the course of the parameters NSE and S100, we analysed possible neurological damages. Furthermore, the patients underwent varied clinical examinations.

Cerebral saturation	pre ECC	pre Aorta-clamp	pre DHCA	ACP start	ACP end	ECC end
INVOS Right [%]	58 ± 12	61 ± 10	54 ± 14	49 ± 14	54 ± 8	64 ± 9

INVOS Left [%]	58 ± 11	64 ± 15	57 ± 14	53 ± 12	57 ± 7	63 ± 8

Table 2.: perioperative course of the cerebral saturation

Results: Five (20%) of the 25 patients died during the early postoperative course. Two of them died as a result of massive bleeding, another three of multiple organ failure. One of the surviving patients had a reversible neurological deficit. At the time of their discharge, none of the survivors showed neurological limitations. Five patients suffered from a temporary postoperative kidney insufficiency (7 ± 5 days).

Conclusion: The deep hypothermic circulatory arrest alone or in combination with the selective antegrade cerebral perfusion improves the neurological outcome of the patients. Decisive for the cooling time and the homogeneousness of the cooling of the brain is the arterial calculation side. The approach at the subclavian artery, truncus brachiocephalicus and the ascending aorta is to be prefered because it reduces the risk of malperfusion in relation to the cannulation of the femoral artery. An existing preoperative limitation of the kidney function turns out to be the primary factor which causes postoperative kidney insufficiency after deep hypothermic circulatory arrest.