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Title: CEREBRAL MITOCHONDRIAL OXYGENATION DURING CPB IN DOGS

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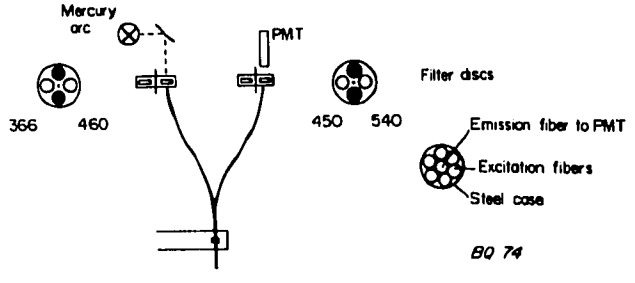
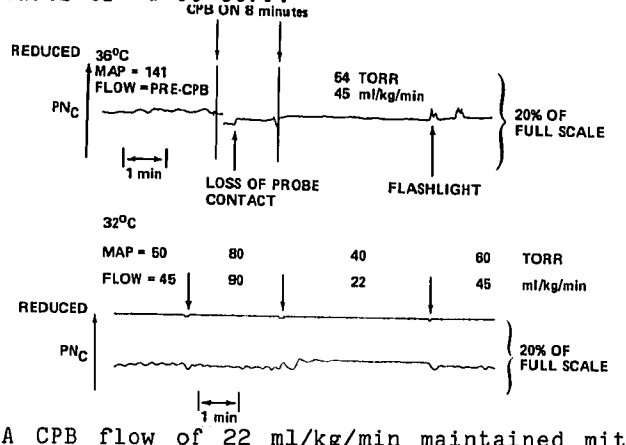
Introduction. Heart surgery with low flow cardiopulmonary bypass (CPB) is followed by a low incidence of neurological and renal complications.[1,2] Nonetheless, flows of 30-50 ml/kg/min remain controversial. To define limiting conditions of CPB we monitored cerebral mitochondrial oxygenation during CPB.

Materials & Methods. We employed the dual beam fluorometer technique developed by Chance et al.[3,4] This method assesses cellular oxygenation and hypoxia by the corrected fluorescence of reduced pyridine nucleotides (PN_c) and oxidized flavoproteins (FP_c). The cerebral cortex of four dogs was exposed and CPB with hemodilution and arterial screen filtration subsequently initiated. PN excitation was obtained by 366 nm light down one arm of a y-shaped multifiber quartz light guide. PN fluorescence at 450 nm was measured by a photomultiplier tube (PMT) at the other arm of the guide. For FP, wavelengths of 450 and 540 nm were employed.

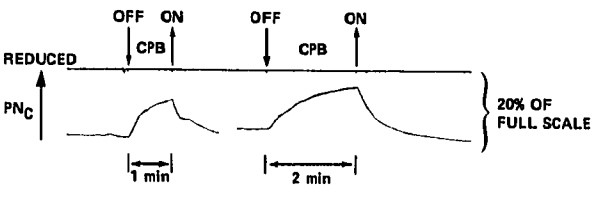


Results. At 37°C there was no difference in cellular oxygenation prior to CPB and at flows of 45-90 ml/kg/min and arterial pressures of 40-80 torr.



A CPB flow of 22 ml/kg/min maintained mitochondrial O_2 at 18°C but not 37°C; 11 ml/kg/min was inadequate at 18°C. Within seconds of temporary cessation of CPB at 37°C cellular hypoxia (mitochondrial reduction) was evident and the EEG became isoelectric.

At 17°C mitochondrial reduction was considerably slower than at 37°C, nonetheless reduction was 90% complete by two minutes.



Discussion. These data are preliminary, but provocative. CPB flows above 45 ml/kg/min were capable of maintaining adequate mitochondrial pO_2 in the cerebral cortex. Temporary interruption of perfusion was associated with rapid mitochondrial reduction. Furthermore the onset of cellular hypoxia was slower but remained relatively rapid at 18°C a finding compatible with data on decreased oxygen utilization at 18°C. Total circulatory arrest at these temperatures is used clinically for periods up to one hour. Thus cerebral protection at 18°C is achieved by a process more complicated than the simple slowing of oxygen consumption by temperature reduction. This observation and data from other studies has led us to speculate that cerebral protection from ischemic insults exists in two dimensions. The goal of bioenergetic protection is to slow oxygen consumption and energy utilization in order to minimize the ischemic insult. The goals of anaplerotic protection are to preserve the ability to repair cellular damage upon restoration of blood flow, and to minimize damage subsequent to the ischemic insult.

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References.

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