Microdialysis – a new diagnostic tool in research of congenital heart surgery

R. Kubicki¹, J. Grohmann¹, M. Siepe², F. Humburger³, C. Benk², A. Rensing-Ehl⁴, B. Stiller¹

¹Department of Congenital Heart Defects, ²Department of Cardiovascular Surgery, University Centre Freiburg, ³Department of Anaesthesiology, ⁴Centre of Chronic Immunodeficiency, University Medical Hospital Freiburg, Germany

Objective
Capillary leak syndrome (CLS) affecting especially neonates and young children after cardiac surgery requiring cardiopulmonary bypass (CPB), contributes to higher morbidity. The mechanism involving the related inflammatory processes is poorly understood. We investigated whether different cytokines, measured with microdialysis, can monitor local inflammation in adipose tissue one of the target organ of CLS and predict the development of CLS on cytokine level, before severe clinical signs appear.

Methods
• Prospective single-centre study with 23 children
  – median age 155 (range 6-352) days
  – median body weight 5.4 (range 2.6-9.2) kg
  – sex (m/w) 9/14
• Serial microdialysis analyses for
  – cytokines (interleukin [IL]-6, IL-8, IL-10)
  – complement activation (C3a)
• CLS quantif. by X-ray subcutaneous-thoracic ratio (S/T)

Results I

<table>
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<tr>
<th>Patients (n = 23)</th>
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<tr>
<td>Duration of CBP (min)</td>
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<tr>
<td>Duration of aortic-clamping time (min)</td>
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<tr>
<td>Lowest temperature during CPB (°C)</td>
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<td>Duration of mechanical ventilation (h)</td>
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<td>CLS (yes/no)</td>
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Values as mean ± standard error of the mean

Comparison of S/T between neonates (black box) and infants (white box) before and after surgery.

Results II

A. IL-6 (pg/ml)

B. IL-8 (pg/ml)

C. C3a ng/ml

A-C: Changing of IL-6, -8 & C3a at 7 time points: (S0) after induction of anaesthesia; (H0) directly after CPB; (H1) 2-4h; (H2) 4-6h; (H3) 6-8h; (H4) 8-10h after CPB and (H5) 24h after CPB.

Changes in subcutaneous C3a levels between patients with CLS and without CLS.

Discussion

• The highest levels of IL-6 (55 pg/ml) and IL-8 (66 pg/ml) were detected two hours after CPB.
• After onset of surgery the C3a levels distinguished rose (167 ng/ml).
• Patients developing CLS disclosed a gentle but significant second rise 8 to 10 hours postoperatively (CLS 64 ng/ml vs. non-CLS 24 ng/ml; p<0.01).
• Younger age (p=0.02), longer bypass time (r=0.48; p=0.021), higher inotropic demand (r=0.67; p=0.001) and longer intubation time (r=0.63; p=0.001) correlated closely with the development of CLS.

Conclusion

• Our results provide evidence of the feasibility of verifying subcutaneously the inflammatory response in pediatrics during and after CPB.
• We are able to disclose age-related differences in the inflammatory response.
• Diagnostic microdialysis implicates the possibility to predict CLS on the cytokine level before severe clinical signs appear.