The Influence of Cardiac Surgery on Intestinal Perfusion in Children with Congenital Heart Disease

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Background

Intestinal perfusion is impaired in children with congenital heart disease (CHD) depending on the hemodynamic status [1]. Especially newborn with duct dependent pulmonary or systemic perfusion are at risk for severe intestinal complications before and after cardiac surgery due to impaired perfusion, cardiopulmonary bypass (CPB) or hypoxia leading to intestinal epithelial barrier dysfunction [2]. Intestinal fatty acid binding protein (IFABP) is a cytosolic protein of mature enterocytes of the small intestine and can be detected only after cell damage in plasma and urine with a free filtration on the kidney. Therefore, it is a biomarker for intestinal injury. To understand the influence of heart failure to intestinal perfusion we analyzed perioperative samples from children with different heart defects.

Methods

We investigated plasma and urine samples from 81 children (mean age 108 d) with 104 surgical events, pre- and postcardiac surgery to understand the influence of hemodynamic changes to intestinal perfusion analysing IFABP by ELISA. Samples were collected before surgery (pre-OP), after anaesthetic induction (post-install), right after surgery (post-OP) and at day one to three after surgery (post-OP 1-3). Depending on the heart defect and hemodynamic status we subdivided the patients in 4 main groups for analysing (Figure 1 and 2):

1 (n=38) Duct or shunt dependent defects with Norwood-type surgery and/or Blalock-Taussig (BT) shunt, Transposition of great arteries (TGA);
2 (n=16) Stage 2 palliation (Glenn), Tetralogy of Fallot (TOF) – repair with existing BT shunt;
3 (n=13) Coarctation of the aorta (CoA);
4 (n=37) stable hemodynamic status: atrial septal defect, ventricular septal defect, pink (without BT shunt).

Results

IFABP can be detected in plasma and urine samples with ELISA. All patients showed a significant peak after surgery in plasma and urine samples (p< 0.001) as an expression of intestinal damage caused by multiple factors e.g. change of perfusion due to anaesthesics, CPB or aortic clamping. Caused by the short halftime of IFABP in plasma and dilution by transfusion of blood products or saline during surgery, urine values were higher at post-OP 0 compared to plasma values in all Groups.

Group 1 to 3 started with a higher burden especially seen in urine samples compared to group 4, possibly as an expression of poor abdominal perfusion caused by shunting with a mismatch of pulmonary and systemic perfusion. IFABP peak levels were reached right after surgery in all groups. Shunt dependency led to higher levels overall, whereas group 2-4 showed a quick decrease after repair and reperfusion in urine samples.

Conclusions

Children with congenital heart disease and especially shunt depending heart defects have a harm for intestinal complications. Anaesthetic induction and surgical repair, independent of the need for CPB, lead to increasing IFABP values, expressing cell damage of the intestine. So IFABP is a good biomarker for indicating intestinal damage due to poor perfusion in children with congenital heart disease. It can be measured in plasma with a short halftime and therefore more stable in urine.

Duct or shunt dependent hemodynamics seem to lead to a higher burden and might indicate a higher risk for intestinal complications not only in the perioperative setting. We could show higher IFABP levels after stage one and before stage two palliation for Children with univentricular circulation compared to all others.

To evaluate the clinical relevance of these findings further investigations will be done.

References

[2] Typpo KV et al.; Pediatric Critical Care Medicine, 2014 (1) pp 1-8

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Figure 1: Plasma-IFABP; Time points: pre-OP, max. 24 h before surgery, post-Install: right after anaesthetic induction, post-OP 0: after administration on ICU, post-OP 1: apx. 12 h after surgery, post-OP 2: 36 h after surgery, post-OP 3, 60 h after surgery

Figure 2: Urine-IFABP; Time points: pre-OP: max. 24 h before surgery, post-Install: right after anaesthetic induction, post-OP 0: after administration on ICU, post-OP 1: apx. 12 h after surgery, post-OP 2: 36 h after surgery, post-OP 3, 60 h after surgery