Neutrophil gelatinase-associated lipocalin as an early indicator of acute kidney injury following pediatric cardiac surgery

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Abstract

Early intervention can significantly improve patient outcomes in acute kidney injury (AKI). In children with underdeveloped kidneys, it takes longer than 24 hours for serum creatinine (sCr) to peak after AKI onset. Furthermore, even very subtle increases in sCr are associated with poor outcomes, making it more difficult to diagnose early AKI in pediatric cases. The urinary neutrophil gelatinase-associated lipocalin (NGAL) levels of 64 patients undergoing pediatric cardiac surgery using cardiopulmonary bypass from June 2018 to February 2019 were measured to evaluate NGAL as an accurate indicator of postoperative AKI. Sixteen patients (25%) developed AKI. The AKI group showed significantly higher Risk Adjustment in Congenital Heart Surgery (RACHS-1) scores ($p = 0.028$) and a significantly longer operative time ($p = 0.048$), cardiopulmonary bypass time ($p = 0.048$), and ventilator use time ($p < 0.001$) than the non-AKI group. After surgery, urinary NGAL was significantly higher in the AKI group with a median of 37.1ng/mL (11.1-148.3) against 5.6ng/mL (1.0-35.8) of the non-AKI group ($p = 0.021$). Using a cut-off value of 11.9ng/mL, the area under the curve of urinary NGAL for predicting AKI was 0.69, the sensitivity was 75%, and the specificity was 44 %. Higher RACHS-1 scores are associated with postoperative AKI. Urinary NGAL shows a moderate correlation with AKI diagnosis, and may be useful for predicting AKI early in the perioperative period.

Key words

neutrophil gelatinase-associated lipocalin (NGAL), acute kidney injury (AKI), pediatric cardiac surgery, cardiopulmonary bypass, The Risk Adjustment in Congenital Heart Surgery (RACHS-1) system

Impact of the tip design of the femoral arterial cannula on distal leg perfusion in minimally invasive cardiac surgery

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Abstract

［Objective］In minimally invasive cardiac surgery（MICS）, leg ischemia is one of the known complications due to the femoral arterial cannulation. We routinely monitor distal leg perfusion based on the regional oxygen saturation（rSO_2） using the near-infrared spectroscopy（NIRS）for the prevention of lower limb ischemia. In this study, we examined the impact of the tip design of the femoral arterial cannula on distal leg perfusion.

［Methods］From April 2014 to September 2017, we performed 106 cases of right thoracotomy MICS with femoral arterial cannulation. We used a cannula with multiple side holes and no wire-reinforced tip in 52 patients（group C）, and a cannula with few side holes and wire-reinforcement in 54 patients（group N）. We adjusted for confounding variables using propensity score matching.

［Results］The rate of drops in rSO_2 value greater than 25% was significantly lower in group N than in group C（15.6% vs 60.0%；$p=0.003$）. No significant difference was observed in other factors.

［Conclusion］In addition to conventional prevention methods, using a wire-reinforced femoral arterial cannula may reduce the risk of lower limb ischemia in MICS.

Key words

minimally invasive cardiac surgery（MICS）, tip design of the cannula, near-infrared spectroscopy（NIRS）, lower limb ischemia

Investigation of index of optimal perfusion using oxygen delivery and venous oxygen saturation in cardiopulmonary bypass -- A two-center observational study -

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Abstract

Venous oxygen saturation (SvO_2) poorly reflects regional oxygen supply-demand imbalance which suggests its limitations as an indicator of adequate perfusion during cardiopulmonary bypass (CPB). Recently, the role of oxygen delivery (DO_2) in CPB has gained attention since studies have shown that maintaining sufficient DO_2 is associated with reduced incidence of postoperative acute kidney injury (AKI). In this study, we investigated the relationship between AKI onset, SvO_2 and DO_2, and examined whether the limitations of SvO_2 could be compensated by monitoring DO_2. We enrolled adult patients (estimated glomerular filtration rate $>60mL/min/1.73m^2$) who underwent open heart surgery using CPB at Juntendo University Hospital and Tokyo Bay Urayasu Ichikawa Medical Center between March 2017 and December 2018. Postoperative AKI was used as an index of optimal perfusion. The area under the curve ($AUC<SvO_2^{75}$, $AUC<DO_{2i}^{300}$) and cumulative time ($Time<SvO_2^{75}$, $Time<DO_{2i}^{300}$) below the cutoff threshold were calculated. Wilcoxon test, Chi-square test, and receiver operating characteristic (ROC) analysis were used to evaluate the relationship between intraoperative variables and postoperative AKI. Patients were stratified into AKI (n=191) and non-AKI groups (n=49). The AKI group had a larger $AUC<DO_{2i}^{300}$ (450 vs 1103; p=0.025) and a longer $Time<DO_{2i}^{300}$ (7.3 vs 16.3min; p=0.016), but $AUC<SvO_2^{75}$ (42 vs 30; p=0.620) and $Time<SvO_2^{75}$ (2.7 vs 3.7min; p=0.771) were not significantly different between the groups. The ROC analysis for AKI incidence showed significant difference between AUC values for $Time<SvO_2^{75}$ and $Time<DO_{2i}^{300}$ (0.098, p=0.028). In both groups, SvO_2 was generally maintained at the usual safe range of 75% or more. However, DO_{2i} was significantly lower in the AKI group, suggesting that maintaining SvO2 above 75% does not prevent postoperative AKI. Maintaining DO_{2i} levels $>300mL/min/m^2$, in addition to the standard SvO_2 monitoring, as target for blood flow management can help ensure optimal perfusion during CPB.

Key words

acute kidney injur, goal-directed perfusion, oxygen supply-demand balance, cardiopulmonary bypass, cardiopulmonary bypass management

Study on influencing factors on heparin reactivity

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Abstract

Recently, it is recommended to keep activated clotting time（ACT）more than 480 seconds during cardiopulmonary bypass（CPB）according to the guideline of American Society of ExtraCorporeal Technology（AmSECT）. However, it is not rare than ACT does not exceed 480 seconds after administration of unfractionated heparin（UFH）. We retrospectively investigated parameters which influenced heparin reactivity in 137 patients out of 272 patients who underwent cardiovascular surgery with CPB from May 2017 to December 2018. One hundred thirty-five patients were excluded to remove influences of initial UFH dose. Heparin reactivity decrease was recognized in 41（30%）patients. Between patients with decreased heparin reactivity（Low group）and others（Hi group）, there were significant differences in age, aortic regurgitation (AR), Hb, TP, ALB/TP, preoperative ACT (PreACT), total UFH dose, and antithrombin（AT）dose. In multivariate analysis, Alb and PreACT were identified as independent parameters influencing decreased heparin reactivity. The evaluation of the suitability of parameters obtained from ROC curve suggested decreased heparin reactivity might be observed when the albumin concentration is 3.8g/dL（cutoff value）or less.

Key words

activated clotting time, unfractionated heparin, heparin reactivity

Experimental study of air intake during A-V MUF and confirmation of the bubble retention capacity of an oxygenator

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Abstract

During the Modified Ultrafiltration (MUF), negative pressure may arise in the oxygenator and air may be sent into the patient. Therefore, we added a flow path with a check valve to the conventional A-V MUF flow path. An experimental study was conducted on the effect of A-V MUF efficiency and measures to prevent air intake from the oxygenator. These experiments on the impact of reduced A-V MUF efficiency due to the addition of a check valve showed no significant impact. An experimental measures to prevent air intake from the oxygenator is although all the pressures became negative, the flow rate of the check valve did not differ much from that of the MUF pump. On the other hands but there was a difference in the time for drawing air due to fluctuations in the MUF pump flow rate. With additional experiments, we found that we could adjust the oxygenator so that it could retain air inside it. Until the air is drawn into the secondary side of the oxygenator air could be retained inside the oxygenator by the surface tension arised in the arterial filter pores. The self-vent technology can remove air from hollow fiber and prevent misfeeding of air. The use of an oxygenator with a check valve and bubble retention function can enhance the safety of MUF.

Key words

Modified ultrafiltration, safety measures, check valve, surface tension, self-venting technology

Association between chloride dose during cardiopulmonary bypass management and postoperative acute kidney injury

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Abstract

［Objective］ Acute kidney injury（AKI）is one of the postoperative complications of cardiac surgery with cardiopulmonary bypass（CPB）. It has been reported that the incidence of AKI is as high as 15-30% and the prognosis is poor.

Chloride（Cl）is a type of electrolyte. Animal studies have shown that Cl itself causes renal vasoconstriction and decreases glomerular filtration rate. However, there are no reports showing the association between Cl dose during CPB management and postoperative AKI.

In this retrospective study, the total Cl dose during CPB management was defined as the total Cl dose from the CPB priming solution, the infusion and blood products used during CPB. The objective of this study was to determine the association between the total Cl dose during CPB management and postoperative AKI.

［Methods］ The subjects were 301 patients aged 18 years or older who underwent open-heart surgery with cardiac arrest by aortic cross-clamping and CPB from January 1, 2016 to December 31, 2018. A multivariate logistic regression analysis was performed to evaluate the association between the total Cl dose during CPB management and postoperative AKI. Confounding factors, which were preselected based on the previous literature reports, included age, sex, preoperative weight, estimated glomerular filtration rate, perfusion pressure during CPB management, the lowest oxygen delivery index during CPB management, and CPB duration.

［Results］ The cutoff value of 18.0 g was obtained for the total Cl dose during CPB management. In the multivariate logistic regression analysis using the cutoff value of 18.0 g, the incidence of postoperative AKI was significantly higher in the category of the total Cl dose ＞18.0 g compared to the category ≤18.0 g（odds ratio: 2.376, P＝0.037）, suggesting that the total Cl dose ＞18.0 g is a statistically significant risk factor for postoperative AKI.

［Conclusion］ In terms of the total Cl dose from the CPB priming solution, the infusion and blood products used during CPB, patients managed with the total Cl dose ＞18.0 g had a higher incidence of postoperative AKI compared to those managed with the total Cl dose ≤18.0 g.

Key words

cardiopulmonary bypass(CPB), cardiopulmonary bypass management(CPB management),

acute kidney injury（AKI），chloride（Cl）