

Role of $\Delta P(v-a)CO_2/\Delta C(a-v)O_2$ ratio as a hemodynamic marker in pediatric congenital cardiac surgery patients: a single center prospective study

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Introduction

Low Cardiac Output Syndrome (LCOS) is one of the most frequent complication in pediatric patients with congenital heart disease undergoing corrective surgery. This condition is associated with a high morbidity, and mortality rate so early recognition is crucial. Up to date, several perfusion markers such as serum lactate concentration and central venous saturation (ScVO₂) have been used to recognize LCOS. Nevertheless, these markers seem to be not completely reliable for identifying a state of global tissue hypoxia. [1]

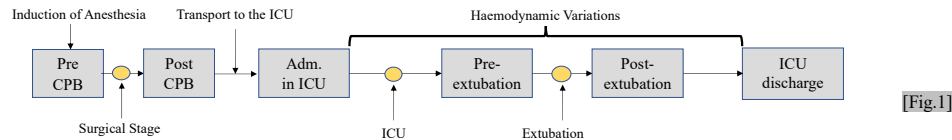
A single parameter cannot resolve hemodynamic instability, the evaluation of the critically ill patient must therefore include a complex integrated approach (clinical trend, vital parameters, invasive and non-invasive hemodynamics monitoring).

Aim of the study

The aim of the study is to establish the ability of the variation of Ratio $\Delta P(v-a)CO_2/\Delta C(a-v)O_2$ ratio to detect LCOS development and the reliability of classical perfusion markers to identify LCOS in a pediatric cardiac surgery population.

Methods and design of the study

Arterial and central venous blood samples were collected and analyzed at different stages of the surgical procedure and postoperative period: Pre-CPB (before starting cardiopulmonary bypass), Post-CPB (after cardiopulmonary bypass weaning), at ICU (Intensive Care Unit) admission, before ventilator support weaning (Pre-extubation), Post-tracheal extubation and at any time of instability or modification of clinical and therapeutic conditions. The variables were analyzed at any stage. They are: PaCO₂, PaO₂, PvO₂, PvCO₂, SaO₂, ScVO₂, lactate, hemoglobin, cerebral and somatic NIRS, inotropic doses, ERO₂, $\Delta P(v-a)CO_2$, creatinine. [Fig.1]

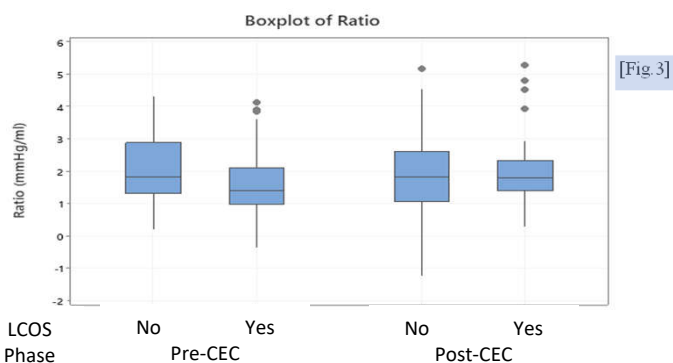
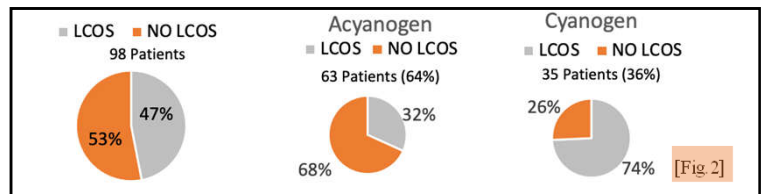


LCOS was defined as the development of organ dysfunction leading to a higher inotropic and vasoactive requirement more than usual CPB weaning support or ICU pharmacological support; furthermore, also acute kidney injury (AKI) was defined according with the Pediatric modified Acute Kidney Injury Network Criteria. Study population included all cyanotic and not cyanotic pediatric congenital heart disease patients (between 0-14 years) undergoing corrective and palliative cardiac procedures.

Fisher's test and the non-parametric Mann-Whitney test was used for statistical analysis.

Measurements and results

98 patients undergoing corrective and palliative cardiac surgery from June 2018 to October 2020 have been included in the study. 46 children of 98 (46,9%) developed LCOS. [Fig.2]



Not statistically significant association between the increase of Ratio and the onset of LCOS was found neither in total population nor in the cyanotic heart disease group. According to literature our Ratio cut off was set at 1.4 mmHg/ml[2][3]. However, between pre-CPB phase and post-CPB phase an average increase in the Ratio values by + 31% was observed in patients developing LCOS. Furthermore, the data showed a decrease in the mean value of Ratio in cases in which LCOS did not develop. The statistical significance was 94% with a p-value 0.06. [Fig.3]

However, it does not appear that the Ratio can be identified as a reliable predictor of the onset of LCOS in the pediatric population affected by congenital heart disease and undergoing cardiac surgery.

Conclusion

The study shows that Ratio can not be identified as a reliable marker of LCOS in the pediatric population affected by congenital heart disease and undergoing cardiac surgery. However, an increase in Ratio, although not statistically significant, is present when LCOS occurs. In conclusion, the trend of the Ratio would be useful not as a single marker but as a component of a much more integrated approach to hemodynamic monitoring of LCOS.

Moreover, the study confirms that serum lactate, ScVO₂, $\Delta P(v-a)CO_2$, ERO₂ are strong markers both pre- and post-operative of LCOS.

References

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