Optimizing Systemic Oxygen Delivery in Single Ventricle Physiology
Qp:Qs as a dynamic factor in the perioperative environment

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ABSTRACT

BACKGROUND: Management of single ventricle physiology in the perioperative environment has been governed by optimizing the balance of the pulmonary to systemic blood flow ratio (Qp:Qs) and systemic oxygen delivery (DO2). The mathematical circulation model of the post Stage 1 procedure in hypoplastic left heart syndrome by Barnea et al suggests that maximal systemic oxygen delivery occurs with Qp:Qs less than or equal to one [Ref 1]. In this model, several assumptions were made: 1) the left ventricle makes no contribution to systemic cardiac output, 2) cardiac output to either 300 or 400 mL/kg/min. Recently, this previous circulation model was modified by also considering cardiac output from the left ventricle and employed computer modeling to investigate parameters to optimize systemic oxygen delivery [Ref 2]. Although keeping Qp:Qs = < 1 has been recommended based on the mathematical model by Barnea et al., the postoperative study of patients who underwent Stage I has suggested that patients at Qp:Qs of about 1.5 may have better outcomes.

OBJECTIVE: 1. Clinical correlation of the mathematical model with actual patient data.
2. To determine whether optimal Qp:Qs is constant and changes depending upon the patient’s clinical condition.

METHODS: 1. Obtained the data from 13 patients with hypoplastic left heart syndrome after Stage 1 procedure and plotted the information as shown in the figures.
2. Using a computer and Excel spreadsheet, equations were employed to examine the systemic oxygen delivery (DO2) and arterial oxygen saturation (SaO2), venous oxygen saturation (SvO2), SvO2 – SaO2 difference, Qp:Qs, and the oxygen excess factor (SaO2/SvO2 – SaO2) as previously described [Ref 2]. We attempted to evaluate the contribution of varying levels of cardiac output and hemoglobin level on Qp:Qs and Qp:Qs to provide resemblance to the perioperative environment (the bleeding patient for instance with a depressed cardiac output), and whether this may change the target endpoints of therapy. Optimal Qp:Qs was defined as the Qp:Qs value that provides the highest oxygen delivery.

RESULTS: 1. As compatible with the mathematical model, real patient data has demonstrated a linear relationship of SaO2/SvO2-SvO2 to systemic oxygen delivery.
2. The contribution of CO (cardiac output) = 200, 400, 600 mL/kg/min, Hgb = 10, 15, 20 g/dL, and of the LV to systemic cardiac output = 0% or 25% was examined in relation to Qp:Qs. Optimal Qp:Qs at various scenarios was summarized in Figure 9. With low cardiac output = low Hgb, Qp:Qs needed to be high in order to be optimal. Whereas SaO2/SvO2-SvO2 was linear in the relationship to oxygen delivery (Figure 10).

CONCLUSIONS: 1. SaO2/SvO2 – SvO2 may serve as an important parameter, although clinical correlation with actual patient data needs further examination.
2. Based on the mathematical modeling, the optimal Qp:Qs was not constant, but rather dynamic target.

REFERENCES

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