Embolization of Veno-venous Collaterals after the Fontan Operation is Associated with Decreased Survival

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Introduction
After Fontan operation, hemodynamically significant veno-venous collateral (VVC) vessels can lead to systemic arterial desaturation. Outcomes after embolization of VVC have not been determined. We sought to determine the frequency of and outcomes for patients undergoing VVC embolization after Fontan operation.

Methods
We retrospectively analyzed clinical and hemodynamic data of patients who underwent cardiac catheterization after the Fontan operation from 1995-2014 at Mayo Clinic. Clinical, imaging, and hemodynamic data from patients with VVC were compared based on intervention (embolization) versus non-intervention.

Results
496 patients with prior Fontan operation were identified. 109 VVC were identified in 72 patients (37 males, mean age 26 ± 12 years). VVC most commonly originated from the innominate vein (43%), inferior vena cava (IVC)/hepatic vein (20%), and the superior vena cava (19%) and most commonly connected to the right upper pulmonary veins (31%), left upper pulmonary veins (23%), directly to the pulmonary venous atrium (18%), and the coronary sinus (17%). Embolization was performed in 31/72 patients (43%). Following embolization, no improvement was demonstrated in systemic oxygen saturation, hemoglobin concentration, and cardiac index declined. Overall, fifteen patients (21%) died at a mean of 2.8 ± 4 years after embolization. 5-year survival of patients with VVC undergoing embolization was 74% compared to 92% in those patients who did not undergo embolization (p < 0.01)(Figure). In multivariate analysis, significant predictors of death were embolization (HR = 9.3 [95% CI, 2.8 – 42], p = 0.0001); atrio-pulmonary Fontan (HR = 4.2 [95% CI, 1.4 – 15], p = 0.01), and heterotaxy (HR = 3.7 [95% CI, 1.0 – 15], p = 0.05).

Conclusion
This is the first investigation to examine outcomes after embolization in patients with VVC after Fontan operation. We observed a significantly decreased 5-year survival in patients who had embolization. Additionally, after embolization no benefit was demonstrated in systemic arterial oxygen saturation and hemoglobin concentration and cardiac index was decreased. Embolization of VVC in patients after Fontan should be avoided especially in patients with atrio-pulmonary type Fontan and heterotaxy. These patients may benefit from the “natural” fenestration that VVC provide.