Complete Blood Transfusion in an ABO-Incompatible Pediatric Heart Transplant

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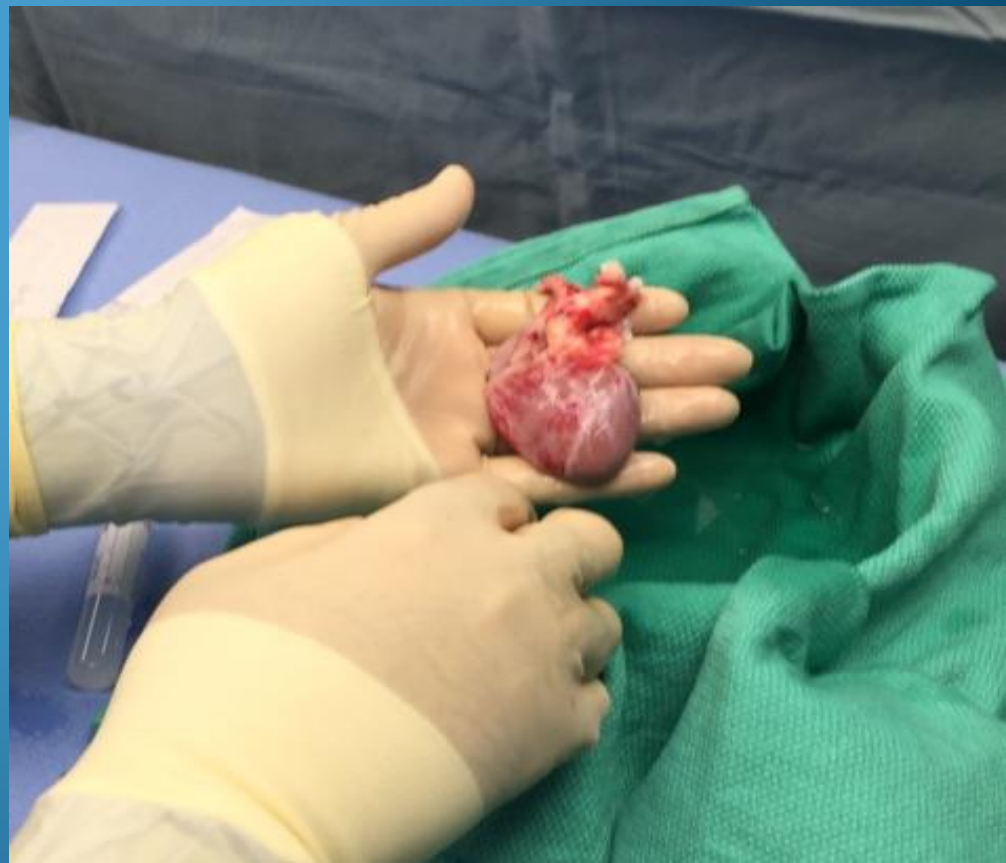
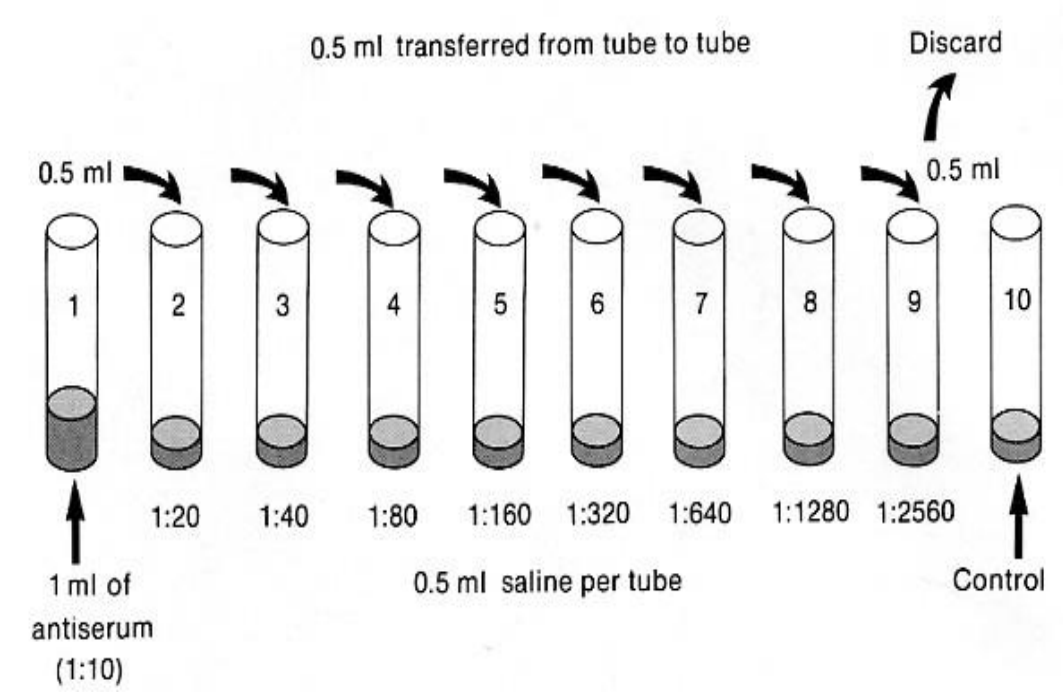


Introduction

- More than half of pediatric transplant patients survive more than 15 years, with non-compatible transplants surviving just as well (1)
- Demand outpaces availability as changes in sleep position have decreased sudden infant death syndrome and child safety car seats have reduced infant death by 71% (2).
- Prior to the institution of ABO-incompatible heart transplants in Toronto, Canada, mortality on the waiting list was 58% and after its institution, mortality declined to 10% (3).

Screening

- Titers are run to determine the level of antibodies present in the recipient
- High titers can lead to hyperacute graft rejection (4)
- Titers are taken every few days prior to transplant to determine levels
- UNOS states infants less than 24 months should have a titer assay of 1:4 or less (3)
- Patients are started on immunosuppressants while awaiting transplant and a complete blood transfusion will be undertaken
- Plasmapheresis is not a viable option



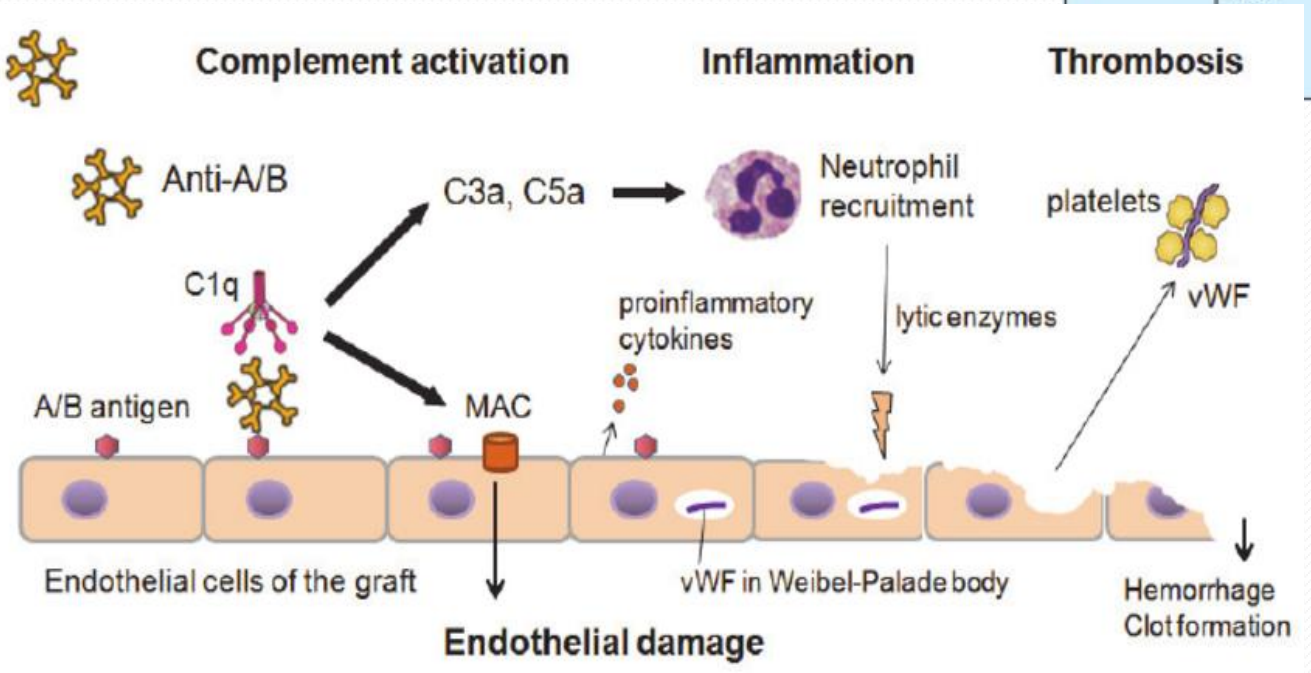
Antibodies

- The isohemagglutinins IgG and IgM bind their respective blood group antigens onto the endothelial cells of the donor organ, causing the complement cascade to start and the graft to thrombose (5).
- In an infant however, isohemagglutinins have not begun to be produced in large numbers until 14 months of age, not allowing the complement cascade to be fully capable of mounting a rejection to the new organ (5).

Rejection

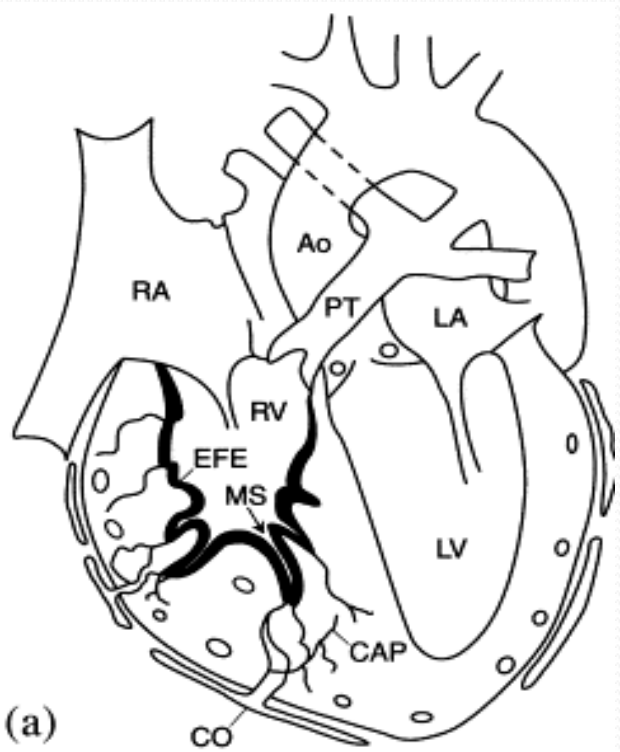
ABO BLOOD GROUPS

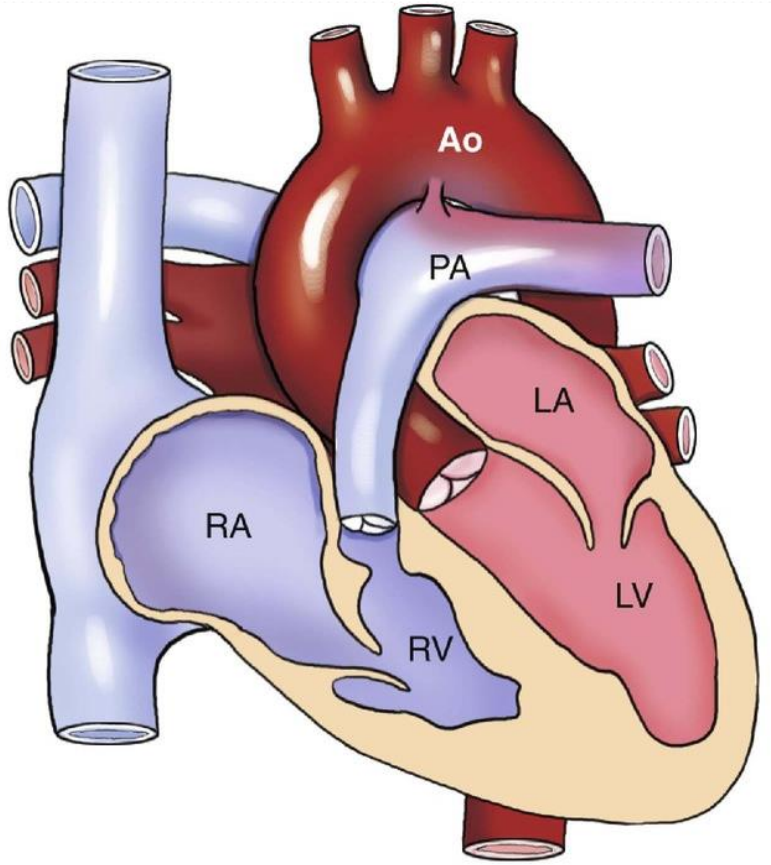
	Antigen A (A_1,A_2, A_x, etc)	Antigen B	Antigen A + B	Neither A or B	Neither A or B or H
Antigen (on RBC)	Density ≈ 10^6/cell	Density ≈ 7.5 x 10^5/cell	Density ≈ 8.5 x 10^5/cell	Density ≈ 10^6 H-antigens/cell	
Antibody (in Serum or Plasma)	Anti-B Antibody	Anti-A Antibody	Neither Antibody	Anti-A, Anti-B and Anti-A,B	Anti-A, Anti-B, Anti-A,B and Anti-H
Blood Type	**Type A** A-subsets can produce anti-A_1 (A_2≈1%; A_2B≈ 25%) Anti-B and anti-A_1 can be clinically significant IgM, IgG, IgA Hemolysin due to complement activation Antibodies found in IVIG	**Type B** Anti-A is more potent with higher titers than anti-B Can be clinically significant IgM, IgG, IgA Hemolysin due to complement activation Antibodies found in IVIG	**Type AB** Type AB No isoagglutinins Ideal for producing IVIG	**Type O** Anti-A and Anti-B similar to Type A and Type B blood Anti-A,B mostly IgG Hemolysin due to complement activation Antibodies found in IVIG Anti-A,B recognizes an antigen that is similar but different from A or B, may be difficult to remove	**Type Bombay** Anti-A, Anti-B and Anti-A,B similar to Type O blood Anti-H highly clinically significant IgM, IgG Rare, likely not ever found in IVIG



Patient History

- 3 Month Old Baby Girl, B+, 4.35 kg, 51.2cm, BSA .25m^2, EBV 435 mL
- Hypoplastic right ventricle, Pulmonary Atresia, Tricuspid Atresia, IVS
- Right Ventricle Dependent coronary circulation
- Coronary Artery Stenosis





Early Interventions

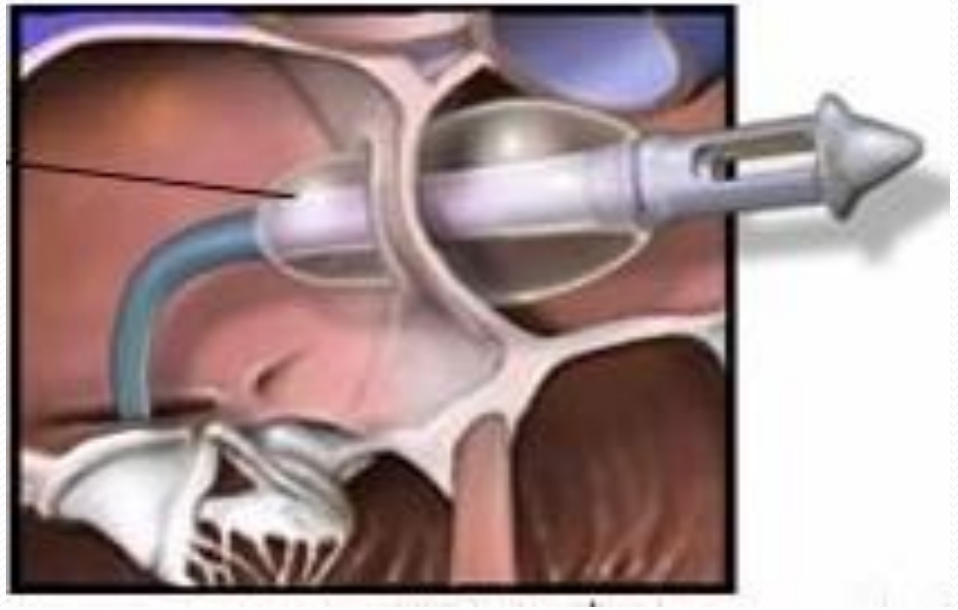
- Started on Prostaglandin E1
- PDA stented
- Atrial balloon septostomy
- Not a single ventricle candidate
- Placed on transplant list under UNOS 1A
  13 days after birth

• A+ Graft became available on day 83

•Titer on day before surgery was 1:16 for Anti-A antibodies

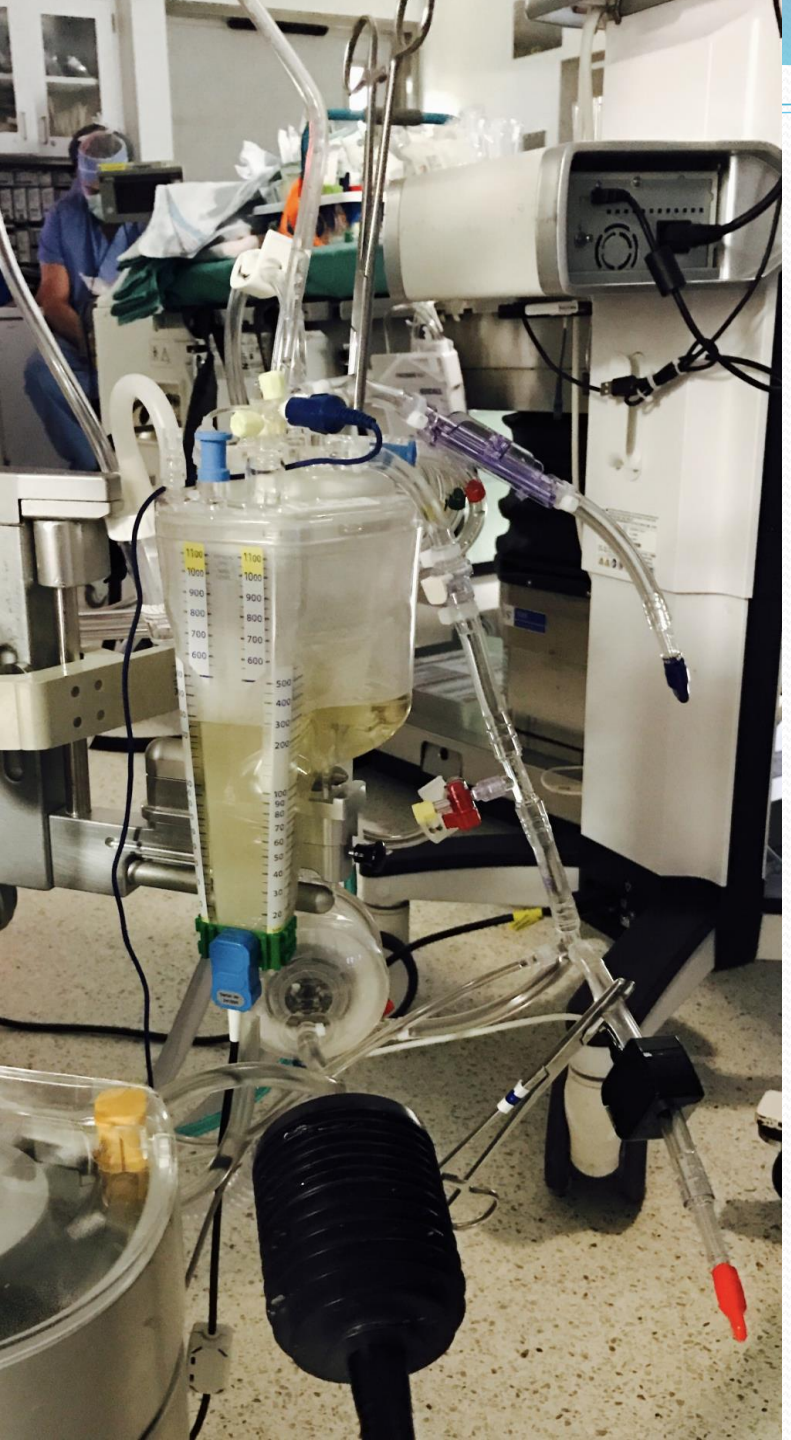
Balloon Atrial Septostomy (Rashkind Procedure)

Procedure to open a hole in the septal wall dividing the left and right atria. The opening in the septum allows oxygen-rich and oxygen-poor blood to mix, improving circulation.



Setup

- Terumo Capiox FX05 Baby Oxygenator with integrated Arterial Filter
- Sorin S5 HL machine with ¼” roller pump boot
- Vacuum assisted venous drainage
- 8 Fr straight DLP aortic (Medtronic)
- 16 Fr straight in IVC and 10 Fr right angle plastic in the SVC (Edwards)
- ¼”, ¼”, ¼” Y in venous line, Quick Prime Line, Blood Collection Bag or reservoir
- Fresenius Continuous Autotransfusion System



Prime Constituents

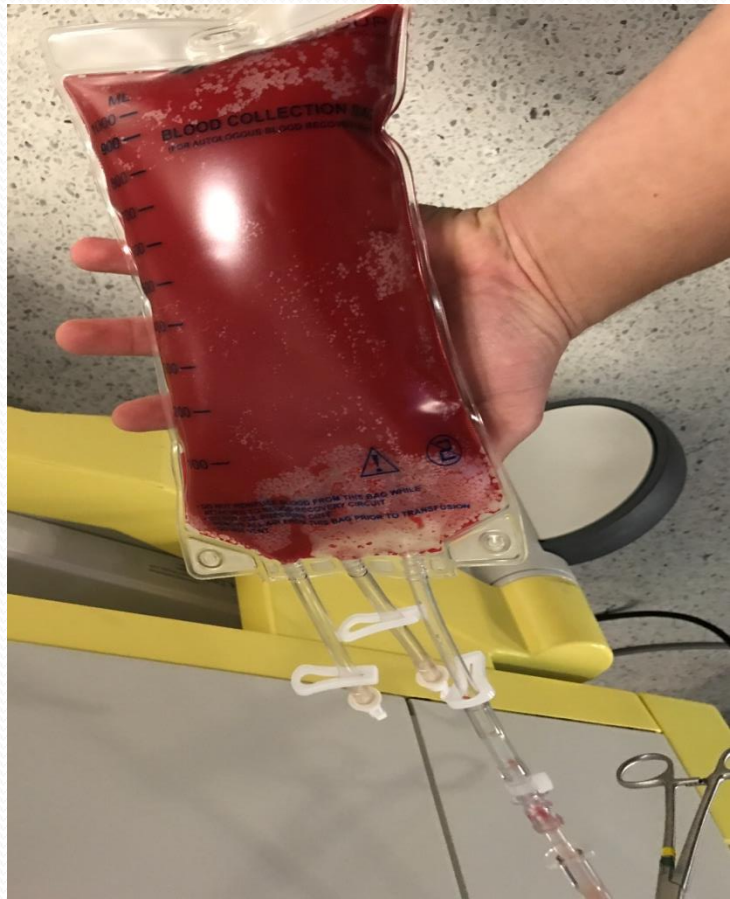
- 500 mL of Plasma-Lyte 148
- 100 mL of 25% Albumin
- 485 mL of O+ irradiated RBCs washed and suspended in .9% NS
- 250 mL of AB+ Plasma
- 15mL of 25% Mannitol
- 3,000 units of Heparin
- Balanced with sodium bicarbonate and calcium chloride added

Blood Selection

ABO of Heart Recipient	ABO of Donor Heart	Select for Transfusion		
		Plasma	Red Cells	Platelets
O	AB	AB	O	AB
O	B	AB or B	O	AB or B
O	A	AB or A	O	AB or A
B	AB	AB	O or B	AB
B	A	AB	O or B	AB
A	AB	AB	O or A	AB
A	B	AB	O or A	AB

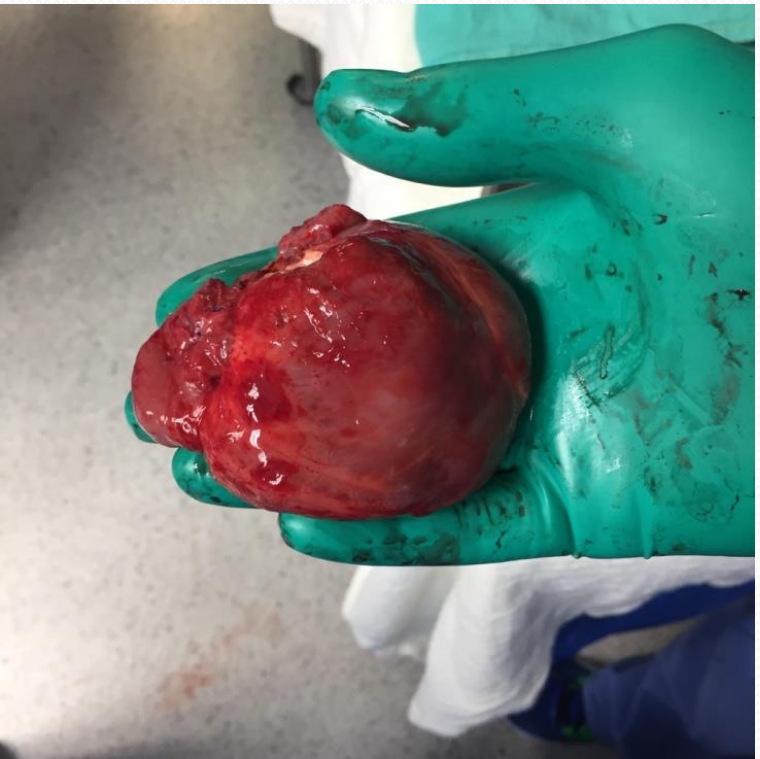
Transfusion

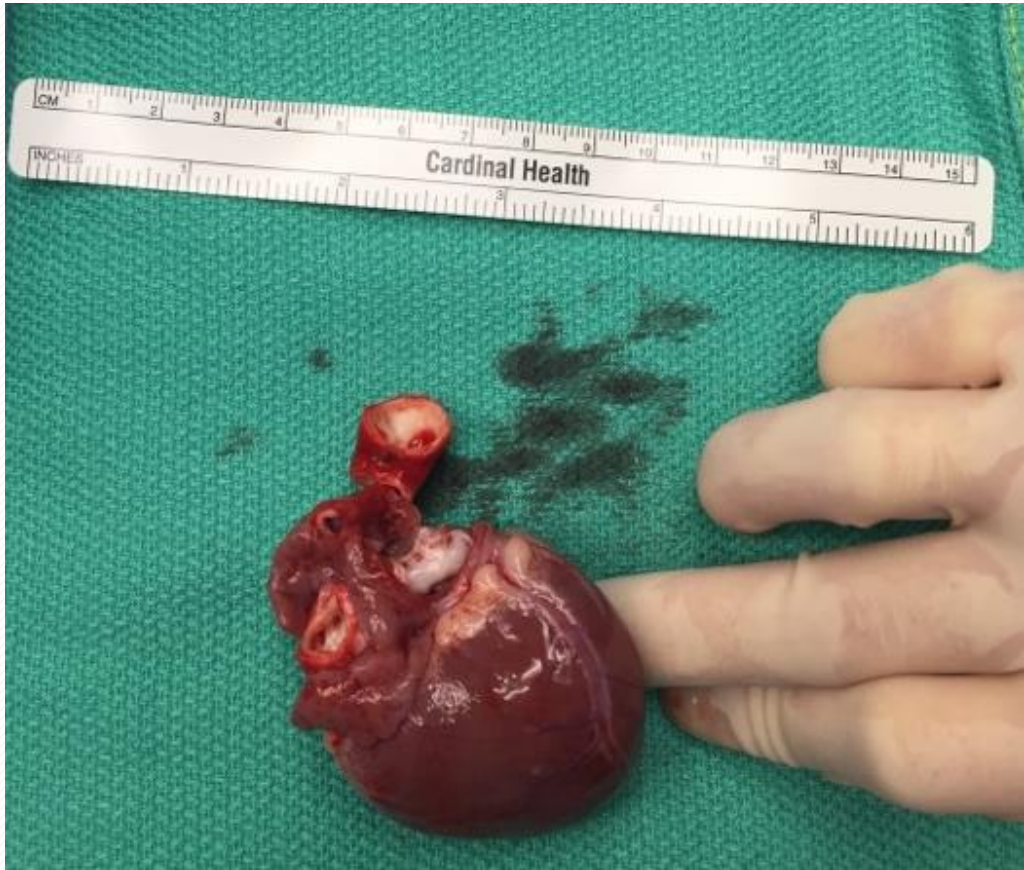
- After heparinization, cannulation, and ACT>480 about 3 times the patient's circulating blood volume was drained into a bag during the initiation of CPB
- Pump suckers were not turned on until after the transfusion took place
- Bicaval cannulation to completely drain atrium
- 1,000 mL removed by Perfusionist
- Antibiotics and Muscle Relaxers were redosed



Post Transfusion

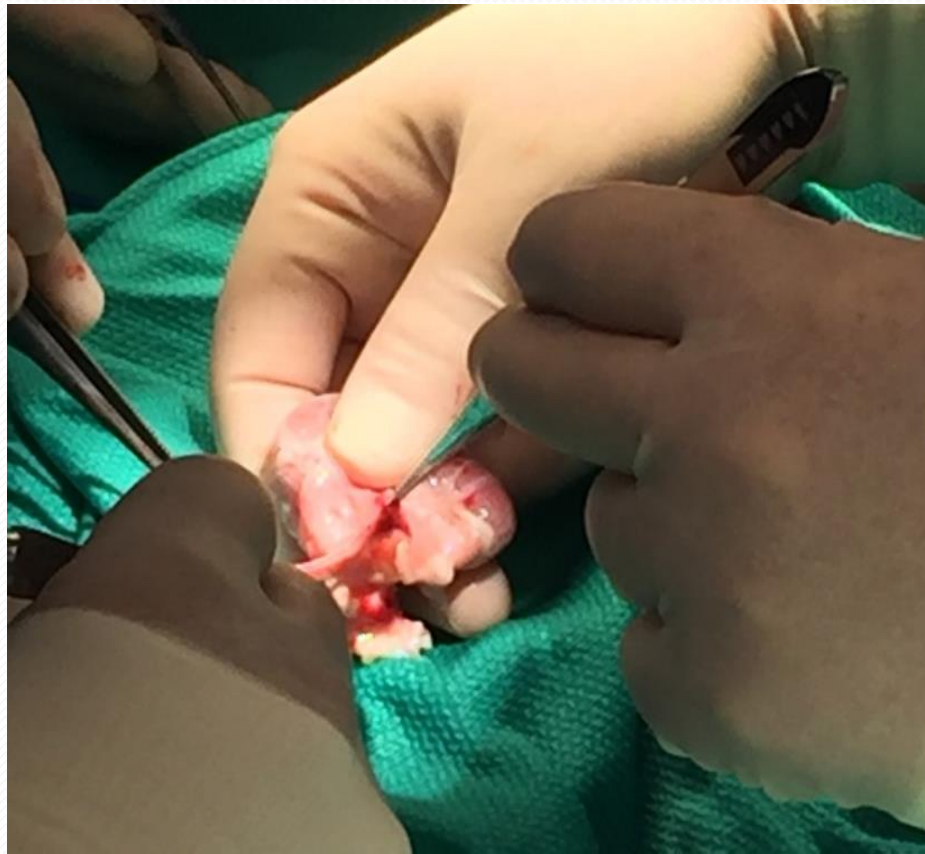
- Patient cooled to 32°C and cross clamped placed and heart is removed
- Titer after 5 minutes on CPB: 1:2
- Del Nido Cardioplegia given after aortic anastamosis
- Titer Before Cross-Clamp removal 1:2





Post Transfusion

- 240 mL of RBCs and 180 mL of Plasma administered before termination of CPB
- Hemoconcentrated until a hematocrit of 35%
- Donor Heart Cross Clamp total of 185 minutes and CPB total of 180 minutes
- Pulmonary HTN upon weaning from CPB
- Weaned successfully with moderate inotropes and ventilatory nitric oxide



Follow Up

- Titer Daily for 7 days, weekly for 3 weeks, every 2 weeks for next 2 months, monthly for 4 months, and finally every 6 months
- Post-OP day 1 titer 1:1
- Patient remained in the hospital for 30 days due to feeding issues and discharged home taking Septra as an antibiotic and Cellecept and Tacrolimus as her immunosuppressants
- Three months following transplant there have been no donor specific antibodies detected and she continues to develop well at home
- Never receive whole blood transfusion
- Breast feeding allowed after transplant

Discussion

- Immaturity of infant's immune system does not allow complement cascade to become fully functional
- Expression of major histocompatibility complex class II molecules are not yet expressed and thus neutrophils don't bind to the antigen
- Wait list for incompatible recipients compared to compatible recipients is 54 to 72 days respectively (3)
- Debate remains as to what age and titer level recipients should be excluded, as reports of success in 1:256 and children up to the age of 9 has been seen

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