Introduction:
Improved survival from congenital heart disease has led to an increasing need for complex reoperation by reentrant sternotomy. Peripheral cannulation and initiation of cardiopulmonary bypass prior to sternotomy to avoid the risk of cardiac injury and massive hemorrhage is an option in adults and larger children, but femoral vessel size precludes this strategy in infants and small children. We describe the management of a high-risk reentry sternotomy in an infant for repair of a giant pseudoaneurysm after prior homograft repair of Tetralogy of Fallot with pulmonary atresia, involving surgical dissection to allow suprasternal cannulation of the innominate artery and subxyphoid cannulation of the inferior vena cava.

Case Description:
A 11-month old, 6.2kg female infant presented for a routine follow-up transthoracic echocardiogram (TTE). She had a prenatal diagnosis of Tetralogy of Fallot, pulmonary atresia, and major aortopulmonary collaterals, and had undergone aortopulmonary window with collateral ligation (age 2 months), followed by complete intracardiac repair with VSD closure, aortopulmonary windowakedown, bilateral patch pulmonary arterioplasty, and placement of a 9mm aortic homograft right to pulmonary artery conduit (age 8 months). TTE showed a large, abnormal echolucent structure in the anterior mediastinum with flow communication into the right ventricle to pulmonary artery conduit, and mild to moderate conduit regurgitation. Cardiac magnetic resonance imaging and right heart catheterization demonstrated a pseudoaneurysm along the anterior mediastinum and in direct contact with sternotomy wires that arose from the superior aspect of the right ventricular outflow tract and measured 6.3 x 5.3 x 3.0 cm. There was flow communication with the conduit, with low-velocity turbulent swirling flow in the pseudoaneurysm.

The child was given midazolam premedication by mouth (0.05 mg/kg) and brought to the operating room with left femoral central venous access in place. After uneventful induction and tracheal intubation, the left femoral artery and right internal jugular vein were cannulated under ultrasound guidance. Aminocaproic acid was administered (150mg/kg bolus prior to incision, 150mg/kg in the bypass prime, and 75mg/kg/hr infusion). Initial surgical dissection involved isolation of the innominate artery and the inferior vena cava at the suprasternal and subxyphoid aspects of the skin incision prior to reentry sternotomy, to allow for cannulation for bypass. Heparin was administered and the remainder of surgical dissection was carried out with the bypass circuit primed and surface cooling initiated. The giant pseudoaneurysm was exposed with meticulous dissection, and found to occupy nearly the entire anterior mediastinum, obscuring all cardiac structures below. Bypass was initiated and the pseudoaneurysm was decompressed, at which point it could be appreciated that the proximal suture line of the conduit hood was intact but the proximal homograft tissue had disrupted to create the connection into the pseudoaneu rms.

The conduit was replaced with a 15mm aortic homograft conduit and the proximal connection to the right ventricle revised, excising the pseudoaneurysm and pseudocapsule. The patient received no more than standard amounts of allogeneic blood products (2 units of packed red blood cells and 1 unit of frozen plasma on bypass, 2 units of cryoprecipitate and 1 unit of volume reduced platelets post-bypass). She was weaned from cardiopulmonary bypass on inotropic (0.5 mcg/kg/min) and had an otherwise uncomplicated postoperative course.

Discussion:
In the largest existing case series of reentry sternotomy in congenital heart disease, the principle risk factors for cardiac injury were number of prior sternotomies and the presence of a right ventricle to pulmonary artery conduit. In adults, peripheral arterial cannulation (femoral, axillary, or subclavian) has been used to initiate bypass prior to sternotomy. This technique decompres s the heart, reducing the risk and mitigating the consequences of cardiac injury on reentry. However, this strategy is not an option in neonates, infants, and small children because of the size of peripheral arteries. In our patient, the femoral arteries were approximately 3 mm in diameter. Even in a larger child with a vessel that could accommodate an adequate size cannula, this strategy carries a significant risk of limb ischemia (sometimes requiring amputation) in children.

In our patient, the carotid arteries (at the level of the thyroid cartilage) were approximately 6mm in diameter. Carotid cannulation is used in children of this size for rescue extracorporeal membrane oxygenation, but the risk of ipsilateral hemispheric stroke is tolerated given the gravity of the underlying condition. We did not believe this was an acceptable risk in our elective cardiac procedure.

There are two additional alternative strategies to peripheral cannulation. Repair of congenital cardiac pathology under surface cooling alone (circulatory arrest without systemic perfusion) has been described with acceptable long-term outcomes, but in our opinion is best viewed as a historical technique. We believe the best alternative is suprasternal dissection to facilitate the use of the innominate artery as the arterial inflow. A variation on this technique, using end-to-side anastomosis of an expanded polytetrafluoroethylene graft to the innominate artery has been described previously. Venous return can be obtained by subxyphoid access to the inferior vena cava, or if other options prove unsatisfactory, by cardiotomy suction.

Lysine analogue antifibrinolitics are effective in reducing microvascular hemorrhage associated with reentry sternotomy. Adequate venous access is needed, and blood products should be available and the cardiopulmonary bypass circuit primed at the time of incision. Close communication and coordination between the surgical, anesthesia, and perfusion teams is essential.

References: