INTRODUCTION

Hypoplastic Left Heart Syndrome (HLHS) is a Congenital Heart Disease (CHD) where the left side of the heart is malformed, including the deformation of the left ventricle and diminutive aortic and mitral valves. The existing three-stage palliative procedure for HLHS has potential for a multitude of complications leading to a 50% survival rate. To reduce the morbidity and mortality rate and mitigate the trauma associated with the procedure, an alternative technique, Hybrid Comprehensive Stage II (HCSSII), featuring the inclusion of a stent and baffle in the left and right pulmonary arteries is proposed. The stent included in Hybrid Stage II has potential to become fractured as a result of oscillatory asymmetric external loads with high local load concentrations. A bench top study shows the effects of fluid pressure on the stent and baffle to infer long term complications.

OBJECTIVE

The objective of this study is to determine the degree to which hydraulic loads on the systemic side affect the baffle and stent complex deformation on the pulmonary arteries.

METHODS

MFL:
- The mock flow loop (MFL) was tuned according to the two sets of given catheter data, namely two 6 months old infants with Body Surface Area (BSA) of approximately 0.54 m² and 0.36 m²
- The MFL is based on a reduced lumped-parameter model (LPM) of the HCSSII circulation, comprised of upper and lower systemic compartments, as well as left and right pulmonary compartments.
- Tuning of Mock Flow Loop
  - Upper Systemic Circulation - 30% of total Cardiac Output
  - Lower Systemic Circulation - 70% of total Cardiac Output
- Right and Left Pulmonary Circulation - 60% and 40% of Upper Systemic circulation respectively

Flow Loop Configuration
- Each lump in MFL comprise of the following: a resistance valve, compliance chamber, flowmeter and pressure transducer
- The Harvard apparatus pulsatile pump was used to replicate the patient specific cardiac outputs by adjusting following parameters.
- By tuning the resistors, the volumetric flowrate (Q) is matched to the desired flowrate observed in the patient specific catheter data.
- Three pressure transducer were connected to the centerpiece to measure Ascending Aorta, Descending Aorta and Pulmonary Trunk pressures.
- For the set flowrate and set compliance values, the analogous physiological values of pressure drops (ΔP) across the MFL lumps were compared with the pressures from the catheter data.

Image Configuration
- Through the inclusion of the digital video otoscope DES500, videos of the stent and baffle are captured during the testing of the MFL for evaluation.
- Videos of the stent and baffle are post-processed using a customized image processing algorithm written in OpenCV.
- Markings are placed on the baffle for reference points among the image processing technique to calculate displacement using pixel coordinates
- Stent measurements of length, thickness, and radius of curvature are collected subsequent to the running of the MFL utilizing Scanning Electron Microscope (SEM) images of the deflated stent.

CONCLUSION

For 10 cycles, stent and baffle deformation is small. Results indicate the left and right pulmonary flow remain unobstructed despite cyclic deformation of the baffle, hence the likelihood of patient death due to total pulmonary obstructions following stent.

REFERENCES