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Analysis of Alternative Polling Strategies for Derivative-Free Optimization of the Fontan Surgery WEIGUANG YANG, UCSD, JEFFREY FEINSTEIN, Stanford University, ALISON MARSDEN, UCSD — We have recently proposed a new design for the Fontan surgery, performed to treat children with severe heart defects. The new design replaces the traditional straight graft between the inferior vena cava and the pulmonary arteries, with a Y-shaped graft. In preliminary work, this design offered superior hemodynamic performance compared to designs used in current practice. Here, we optimize an idealized Y-graft design under a range of rest to exercise pulsatile flow conditions using the surrogate management framework (SMF) and mesh adaptive direct search (MADS). Constraints are added to the problem using a filter method. In particular, we assess and compare the performance of two recently developed polling strategies used in the SMF algorithm: LTMADS and OrthoMADS. Although LTMADS works well in many applications, it chooses the polling directions randomly and may result in large angles between poll directions. OrthoMADS generates deterministic and orthogonal polling directions, which avoids the drawbacks above while still producing a dense set of directions. Finally, we extend the SMF method to incorporate multiple objectives based on clinical outcome data for Fontan patients.

Weiguang Yang
UCSD

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