Extended preservation of arterial conduits in GALA: multiphoton microscopic evaluation

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Purpose: Injury to endothelium can compromise patency of bypass conduits and adversely affect long-term outcomes. We have previously shown that GALA, a synergistic physiological salt solution of our design, that provides energy and nitric oxide substrate, free radical scavenger and reducing agent, significantly preserves endothelial and smooth muscle cell (SMC) function in human saphenous vein (HSV) during ex vivo storage, resulting in improved outcomes. We evaluate the role of GALA in preservation of endothelium and SMC in arterial conduits (radial artery, RA; internal mammary artery, IMA), during short and long-term storage. We hope that as in HSV, successful preservation of viable conduits may improve patient outcomes and prove beneficial, especially for conduit compromised revascularization patients.

Methods: Multi-photon microscopy (MPM) was used to image deep within conduit tissue for evaluation of endothelial and SMC structure and function. Viability, esterase activity, bradykinin stimulated activation of eNOS, calcium mobilization, and nitric oxide generation was determined in real time using fluorescence markers and MPM. Western blots (WB) were utilized to analyze conservation of vWF and eNOS in the conduits. Heparinized papavarin blood (HPB), heparinized lidocaine saline (HLS) were used as comparators for GALA. Conduits were stored in HLS, HPB or GALA for 60 min (21°C) to 72 days (4°C). When feasible, HSV from the same patients were used as internal control.

Results: Within 60 minutes of storage in HPB and HLS, calcium mobilization and nitric oxide generation were markedly attenuated with greater than 90% of endothelial cells demonstrating injury in RA and HSV. In contrast, HSV, RA and IMA conduits stored from 24 hour to 72 days in GALA demonstrated robust esterase and eNOS activity, calcium mobilization and nitric oxide generation, without any substantial loss in cell viability similar to freshly harvested control vessels. WB demonstrated that vWF and eNOS were well conserved in conduits preserved for 72 days in GALA, but not in cryovessels.

Conclusions: We provide evidence that surgical conduits can be preserved in GALA for extended period. Standard solutions in clinical use today lead to profound decline in conduit viability within 60 min, in contrast, GALA fully preserves endothelial and SMC structure and function during prolonged storage. The improvements seen from using GALA as a vessel storage medium may lead to greater long-term graft patency following CABG and PVS. GALA stored vessels may also provide alternative resource, especially for conduit-compromised patients.