Perfusion Preservation Maintains Myocardial ATP Levels and Reduces Apoptosis in an Ex Vivo Rat Heart Transplantation Model

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BACKGROUND: Machine perfusion preservation improves reperfusion function of many solid organs, compared with conventional storage, but has received limited clinical attention in preserving hearts for transplantation. We evaluated representative extracellular (Celsior) and intracellular (University of Wisconsin) storage solutions using static and perfusion protective strategies over a clinically relevant preservation period.

METHODS: Rat hearts were preserved for 200 minutes by either static storage or perfusion preservation in Celsior or University of Wisconsin solutions. Three conditions were studied: conventional static storage; static storage using either solution with 5.5 mmol/L glucose added; and perfusion preservation using either solution with 5.5 mmol/L glucose added. Glucose was provided as U-13C-labeled glucose, and glycolysis and oxidative metabolism during preservation were quantified from incorporation of (13)C into glycolytic and tricarboxylic acid cycle intermediates. Adenosine triphosphate levels after preservation, and apoptosis and cardiac function after reperfusion were measured.

RESULTS: Both perfusion preservation groups had higher myocardial oxygen consumption during storage and better early graft function, compared with static preservation groups (P < .05). Adenosine triphosphate levels were higher after storage in the perfusion groups (P < .01). Apoptosis was reduced in the perfusion groups (P < .01). Comparing perfusion groups, hearts preserved with Celsior had higher myocardial oxygen consumption and glucose utilization during perfusion storage and exhibited decreased reperfusion coronary vascular resistance and myocardial water content, compared with the UW perfusion group (P < .05).

CONCLUSIONS: Perfusion preservation results in greater metabolism during storage and superior cardiac function with improved myocyte survival, compared with static storage. Extracellular preservation solutions appear more effective for perfusion preservation, possibly by augmenting cellular metabolism.