Medical Xpress

Donor livers preserved and improved with room-temperature perfusion system

May 6 2014

A system developed by investigators at the Massachusetts General Hospital (MGH) Center for Engineering in Medicine (CEM) and the MGH Transplant Center has the potential to increase both the supply and the quality of donor organs for liver transplantation. In their report, which has been published online in the *American Journal of Transplantation*, the research team describes how use of a machine perfusion system delivering a supply of nutrients and oxygen though an organ's circulation at room temperature preserved and improved the metabolic function of donor livers in a laboratory study. The system has not yet been tested clinically.

"By the time a donated organ is transplanted, it has sustained significant injury through lack of a blood supply," says Bote Bruinsma, MSc, of the MGH-CEM and Department of Surgery, lead author of the report. "By supporting metabolic function, we can give the liver time to recover, preconditioning it before transplantation. The hope is that, in the near future, livers that currently are considered unsuitable for transplantation will be recovered by more advanced preservation techniques, significantly increasing the number of organs available for transplantation."

The continuing shortage of donor organs has already led to the limited use of organs from donors who do not meet the strict criteria for brain death but in whom death from cardiovascular failure is imminent and organs can be procured soon after death. The quality of organs from such donors is often less than that of organs procured after brain death because of the greater time elapsed between when circulation ceases and when the surgically removed organ is cooled for transportation. The authors note that increased use of such "marginal" organs requires improved methods of preservation beyond simple cold storage, which only slows the process of deterioration.

Several studies have shown that perfusing donor livers with a cold solution can reduce tissue damage, and small clinical trials found evidence that cold-perfusing livers prior to transplantation improved the donor organs' function. But while cold perfusion delays the restoration of the organ's metabolic activity until it is implanted, use of a warm perfusion solution could initiate several aspects of organ recovery before implantation, potentially allowing better assessment of the organ's viability than is currently possible. Studies of systems perfusing donor livers at body temperature have supported this possibility, but the author notes that rapidly warming and reoxygenating a cold-stored organ – either by perfusion at body temperature or by direct implantation into a recipient – causes further damage to an organ already compromised by the interrupted blood supply. This damage is an even greater concern when marginal organs are used.

The system evaluated in the current study perfuses the organ with a room-temperature (around 70° F) solution. Through the New England Organ Bank the investigators acquired seven donor livers – only two donated after brain death – that had been judged unsuitable for transplant for a number of reasons. The organs were connected to the perfusion system via the hepatic artery and portal vein and perfused with a room-temperature solution containing oxygen, vitamins and other nutrients, and antioxidants for three hours following several hours of cold storage. Analysis of the fluid coming out of the livers during perfusion revealed that the organs were metabolically active – producing bile, albumin and urea – and markers of tissue damage were limited. Levels of the cellular energy molecule ATP in liver tissue actually increased during perfusion, implying that the process could help recover, not just preserve, the organ's function, potentially allowing the safe use of organs currently being discarded.

Bruinsma adds that measuring these and other metabolic signals during perfusion could significantly improve the ability to assess the quality of a donated liver, which is currently done based on limited parameters. "Demonstrating the feasibility of this approach in human livers is an enormous step forward in bringing this technology to clinical application," he explains. "We expect that perfusion systems will revolutionize the way the liver is preserved outside the body, significantly increasing the number of livers available for transplants and saving the lives of potentially thousands of patients." Bruinsma is an MD/PhD candidate at the University of Amsterdam and visiting graduate student in the MGH Department of Surgery

Korkut Uygun, PhD, of the MGH Center for Engineering in Medicine, a co-corresponding author of the report, adds, "We like how simple and straightforward this protocol is. It doesn't involve all the bells and whistles of temperature control or use of blood or similar oxygen carriers, and yet the liver clearly still continues to work and heal itself in this environment, which makes us very optimistic about rapid clinical translation and adoption." Uygun is an assistant professor of Surgery at Harvard Medical School.

Provided by Massachusetts General Hospital