

# Liver Transplantation from a Non-Heart-Beating Donor After Pulmonary Failure: Report of a Case

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## Abstract

We report a case of successful liver transplantation after controlled donor after cardiac death procurement from a donor who died of pulmonary failure. The donor was a 28-year-old woman with idiopathic pulmonary fibrosis, whose life support could not continue when her condition deteriorated rapidly while waiting for a suitable donor for lung transplantation. She was on noninvasive negative pressure ventilatory support before the donor organs were procured.

**Key words** Liver transplantation · Donation after cardiac death · Idiopathic pulmonary fibrosis · Negative pressure ventilation

## Introduction

The number of patients awaiting organ transplantation and the discrepancy between donor and recipient numbers continues to rise. Strategies to increase cadaveric donation include the use of organs procured from donors after cardiac death (DCD).<sup>1</sup> We report a case of controlled DCD procurement from a donor who was on non-invasive negative pressure ventilatory support with a chest cuirass for idiopathic pulmonary fibrosis (IPF). The liver and kidneys were procured and successfully transplanted.

## Case Report

A 28-year-old woman, 153 cm tall and weighing 45 kg, who was dying after being on the waiting list for lung transplantation for end-stage IPF, was referred to our

unit for a controlled cardiac death after a decision had been made to withdraw supportive treatment.

Idiopathic pulmonary fibrosis is a chronic, progressive interstitial lung disease of unknown etiology, characterized by inflammation and fibrosis of the lung parenchyma. No specific clinical or pathologic findings are associated with IPF and the diagnosis is made by exclusion. This patient was admitted to hospital with a 7-day history of headache with nausea, vomiting, neck stiffness, and numbness of the lower extremities. She was afebrile, awake, and oriented to person, place, and time. Computed tomography of the brain was reported as normal and lumbar puncture showed an elevated intracranial pressure with no other abnormalities. Her arterial blood gas on arrival was as follows: pH, 7.38; pO<sub>2</sub>, 19.9 kPa; pCO<sub>2</sub>, 10.8 kPa; HCO<sub>3</sub><sup>-</sup>, 44 mmol/l. On hospital day 3, she became drowsier and unable to maintain adequate ventilation. The pulmonary physician decided against intubation and mechanical ventilation because this would have jeopardized her chance of transplantation since patients requiring mechanical ventilation are not amenable to transplant.<sup>2</sup> The aim of treatment was to stabilize her condition without intubation and ventilation, keeping the oxygen level in the range of 8 kPa with oxygen saturation of greater than 95%. Positive pressure ventilation was not tolerated so she was supported with noninvasive negative pressure ventilation using a chest cuirass composed of a domed plastic shell that covered the patient's chest and upper abdomen and a motor connected to the shell.<sup>3</sup>

Despite the negative pressure ventilatory device, she deteriorated with a rise in pCO<sub>2</sub> level to 18.9 kPa and pH 7.15. Other results included pO<sub>2</sub>, 15.31 kPa and HCO<sub>3</sub><sup>-</sup>, 37.9 mmol/l. She was given high doses of adrenaline, noradrenaline, and dobutamine. In a final attempt to improve her condition, she was intubated and mechanical ventilation was started. Despite this, her condition continued to deteriorate and within 24 h it became clear that this would not be reversible. It was

Reprint requests to: W. Faraj

Received: March 3, 2008 / Accepted: August 10, 2008

explained to her family that she was dying and that transplantation was no longer a possibility. The family agreed that it would be appropriate to withdraw supportive treatment. After this decision was final, and independent of it, the option of organ donation was brought up by the family. After discussing the issues of controlled non-heart-beating donation with the transplant coordinators, the family agreed to proceed.

The laboratory values at referral were as follows: serum sodium, 126 mmol/l; serum creatinine, 43  $\mu$ mol/l; total bilirubin, 8  $\mu$ mol/l; serum alanine aminotransferase, 20 IU/l; and aspartate aminotransferase, 40 IU/l. Cytomegalovirus IgG was positive, but otherwise the viral screen and blood cultures were negative. Medical support was withdrawn by stopping all medications and turning off the ventilator, according to the guidelines provided by the General Medical Council in the United Kingdom; namely, "Withholding and withdrawing life-prolonging treatments: Good practice in decision-making".<sup>4</sup> The time from withdrawal to cardiopulmonary arrest was 21 min.

Death was declared 5 min after cardiac arrest by the intensive care physician. Procurement was performed using a modified super rapid technique originally described by Casavilla et al.<sup>5,6</sup> The surgical set was adapted and simplified for a quick setup and draping. The preservation fluids used were Marshall's solution to flush the aorta and University of Wisconsin (UW) solution for portal perfusion. Heparin (20000 units) was added to both solutions. A midline thoracoabdominal incision was made and congestion in the area of the inferior vena cava was relieved by drainage through a large incision in the right atrium. A 28-F cannula was inserted into the aorta for perfusion and topical cooling was done with normal saline slush. The aorta was clamped above the diaphragm. The superior mesenteric vein was cannulated and portal perfusion was commenced with UW solution. The procedure continued similarly to a conventional retrieval, taking care not to divide any possible anomalous hepatic or renal vessels. The warm ischemia time from hypotension (systolic blood pressure <50 mmHg) to aortic perfusion was 29 min and the time from cardiac arrest to aortic perfusion was 9 min.

The donor liver weighed less than expected (795 g), and the recipient was changed, leading to a cold ischemia time of 12 h. The final recipient was a 12-year-old girl with Langerhans cell histiocytosis, an idiopathic disorder characterized by the proliferation of specialized bone marrow-derived Langerhans cells and mature eosinophils. An orthotopic liver transplant was done using a piggyback technique with a temporary portocaval shunt. Immediate graft function was excellent, and the recipient was discharged from the intensive care unit after 24 h and went home on postoperative

day 12 with excellent graft function. At the time of writing, 13 months after transplantation, she is well with normal liver and renal function tests, on tacrolimus immunosuppression, with trough levels between 5 and 8  $\mu$ g/l.

## Discussion

The rate of liver donors in the United Kingdom is currently among the lowest in Europe, at about 13 per million population. However, in 2006 the number of people awaiting liver transplantation increased by 40%.<sup>7</sup> Donation after cardiac death has been proposed as a way of increasing the number of grafts available by as much as 20%. Our experience of DCD liver transplantation over the past 5 years includes 70 transplants with a primary nonfunction rate of 5%, a vascular complication rate of 9%, and a biliary complication rate of 12%. Actuarial patient and graft survival is 92.5% and 90% at 1 year and 87.2% and 83.9% at 2 years, respectively, with a mean follow-up post transplant of 25 months (range: 1–70).<sup>8</sup> Of 155 DCDs referred to our unit, three were referred with end-stage respiratory disease. The first was not accepted for organ donation because of a history of heavy alcohol consumption. The second potential donor was accepted, but did not die after withdrawal of treatment within the currently accepted times of 1 and 4 h, respectively, for controlled liver and kidney donation. The third is the subject of the present case report.

There are now explicit guidelines on withholding and withdrawing life-prolonging treatment in the United States, Europe, and the United Kingdom. In the United Kingdom, the British Medical Association<sup>9</sup> and the General Medical Council guidelines<sup>10</sup> are helpful points of reference. The aim of all treatment is to maintain health, but when this fails the validation for providing that treatment no longer exists. Treatment that does not provide any advantage or benefit to the patient may be ethically and morally withheld or withdrawn.<sup>11</sup> To date, there has been no report of successful liver donation and transplantation from a donor with end-stage pulmonary disease, after cardiac death. Referral of potential controlled DCD with end-stage pulmonary disease, though a rare indication of elective withdrawal of treatment, should be carefully evaluated, as transplantable organs can be retrieved successfully.

The number of liver transplants from DCD donors is increasing, with results comparable with those of cadaveric heart-beating donors. This increase in organ availability is favorable for patients with various types of end-stage liver disease, including that resulting from hereditary disorders such as cystic fibrosis.<sup>12</sup>

## References

1. Reddy S, Zilvetti M, Brockmann J, McLaren A, Friend P. Liver transplantation from non-heart-beating donors: current status and future prospects. *Liver Transpl* 2004;10:1223–32.
2. NHS Blood and Transplant. [www.uktransplant.org.uk/ukt/about\\_transplants/organ\\_allocation/cardiothoracic/national\\_protocols\\_and\\_standards/protocols\\_and\\_standards/patient\\_assessment.jsp](http://www.uktransplant.org.uk/ukt/about_transplants/organ_allocation/cardiothoracic/national_protocols_and_standards/protocols_and_standards/patient_assessment.jsp). Accessed Feb 2005.
3. Cornwell JB, Davis HN. Historical perspective, current applications: the chest cuirass. *Respir Ther* 1979;9:87–90.
4. General Medical Council. [www.gmc-uk.org/guidance/current/library/withholding\\_lifeprolonging\\_guidance.asp](http://www.gmc-uk.org/guidance/current/library/withholding_lifeprolonging_guidance.asp). Accessed 2006.
5. Casavilla A, Ramirez C, Shapiro R, Nghiem D, Miracle K, Fung JJ, et al. Experience with liver and kidney allografts from non-heart-beating donors. *Transplantation* 1995;59:197–203.
6. Muiesan P, Giralda R, Jassem W, Melendez HV, O'Grady J, Bowles M, et al. Single-center experience with liver transplantation from controlled non-heartbeating donors: a viable source of grafts. *Ann Surg* 2005;242:732–8.
7. NHS Blood and Transplant. [www.uktransplant.org.uk/ukt/statistics/transplant\\_activity\\_report/current\\_activity\\_reports.jsp/ukt/tx\\_activity\\_report\\_2006\\_uk\\_pp34-38.pdf](http://www.uktransplant.org.uk/ukt/statistics/transplant_activity_report/current_activity_reports.jsp/ukt/tx_activity_report_2006_uk_pp34-38.pdf). Accessed 2006.
8. D'Alessandro AM, Hoffmann RM, Knechtle SJ, Odorico JS, Becker YT, Musat A, et al. Liver transplantation from controlled non-heart-beating donors. *Surgery* 2000;128:579–88.
9. British Medical Association. *Withholding and withdrawing life prolonging medical treatment: guidance for decision making*. London: BMJ Publishing Group; 1999.
10. General Medical Council. *Withholding and withdrawing life-prolonging medical treatment: good practice in decision-making*. London: General Medical Council; 2002.
11. Truog RD, Cist AF, Brackett SE, Burns JP, Curley MA, Danis M. Recommendations for end-of-life care in the intensive care unit: The Ethics Committee of the Society of Critical Care Medicine. *Crit Care Med* 2001;29:2332–48.
12. Ikegami T, Sanchez EQ, Uemura T, Narasimhan G, Masannat O, Chinnakotla S, et al. Liver transplantation for cystic fibrosis in adults. *Surg Today* 2008;38:26–9.