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Broadening Criteria for Donor Livers: Successful Liver Transplantation of 2 Donor Livers With Portal Venous Gas

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Optimization in liver transplantation (LT) surgical techniques and posttransplantation care have resulted in improvement in outcomes over time.[1] However, the application of LT to those in need is limited by availability of suitable deceased and living donors. Underutilization of the deceased organ donor resource may contribute to waiting list mortality. In 2021, the deceased donor rate in Australia was 16.4 per million and the liver transplant waiting list mortality was 4.9%.[1,2]

Portal venous gas (PVG) is a concerning radiological sign that can be associated with catastrophic pathology, such as bowel ischemia, and carries increased risk of mortality.[3] Therefore, it is unsurprising that PVG identified in the donor liver has typically contraindicated transplantation. In the context of the need for increased utilization of donor organs, we present 2 successful LTs using donor livers with pretransplantation findings of PVG. To the authors' knowledge, these are the first such cases reported.

CASE DESCRIPTION

Two hundred fourteen deceased donor offers were made to the Victorian Liver Transplant Unit in 2022 and 77 liver transplants were performed; the reported cases represent 2 of these donor offers. There were no other donors with PVG among the other 212 potential donors. Written consent for reporting the cases was obtained from the LT recipients. There are no identifying details regarding the donors, and so consent from donor decision makers was deemed unnecessary by our ethics committee. Data were collected from the transplant confidential donor data report transmitted by DonateLife, the organ procurement agency in Australia, to transplant units, the Victorian Liver Transplant Unit database, and the Austin Hospital electronic medical record.

The donor demographic and clinical characteristics are presented in Table 1. Donor 1 was a 27-y-old woman who was declared brain dead 1 d after a subarachnoid hemorrhage. A circulatory arrest of 15-min duration occurred at the time of the event. There was mild elevation of the alanine transaminase and gamma-glutamyl transferase and leukocytosis was present throughout the donor's inpatient course. The organ offer was made on day 2 and organ procurement occurred on day 4. Donor 2 was a 36-y-old man who was declared brain dead 6 d after an out-of-hospital circulatory arrest that lasted 40 min. The peak alanine transaminase was 524 IU/L at admission and had recovered to 122 IU/L by the time of organ offer on day 7. There was leukocytosis on admission and leukopenia before organ procurement that occurred on day 8. Neither donor showed signs of uncontrolled infection and there were no positive cultures at the time of organ offer. Computed tomography (CT) scan showed the presence of intramural gas in the stomach and PVG in both donors (Figures 1 and 2).

Broad-spectrum antibiotics (piperacillin/tazobactam in both cases and additionally ceftriaxone in donor 2) were administered to the organ donors throughout their hospital course and no change to the standard antibiotic prophylaxis was instituted in these donors. Careful evaluation of the liver and entire gastrointestinal tract was undertaken at the time of organ recovery, and there was no evidence of ischemia or sepsis. At procurement, the organs were flushed with a low-viscosity solution followed by a University of Wisconsin solution via an aortic cannula, and the liver was also flushed with the University of Wisconsin solution via the portal vein and hepatic artery on the back table.

The recipient demographic, clinical characteristics, and postoperative outcomes are presented in Table 2. Recipient 1 was a 42-y-old woman with autoimmune hepatitis. Vancomycin and cefepime were administered on induction of anesthesia and continued for 2 d postoperatively. Routine

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TABLE 1.

Donor demographic and clinical characteristics

Variable	Donor 1			Donor 2		
Age, y	27			36		
Sex	Female			Male		
Body mass index, kg/m^2	38.7			28.6		
Cause of death	Subarachnoid hemorrhage			circulatory arrest		
Pathway	Brain death			Brain death		
circulatory arrest time, min	15			40		
Cold ischemia time, min	321			343		
Storage method	Static cold storage			Static cold storage		
Timing of variables	Initial	Peak[a]	Terminal	Initial	Peak[a]	Terminal
Bilirubin, μmol/L	11	15	12	10	14	10
ALT, IU/L	71	71	85	524	524	122
ALP, IU/L	70	77	77	135	135	66
GGT, IU/L	42	113	113	509	509	220
Lactate	1.6	1.6	0.8	6.5	NR	NR
pH	7.46	7.45	7.45	NR	NR	7.39
Base excess, mmol/L	+3	–3	–3	NR	NR	0
Whit cell count, ×10^9/L	26.4	26.4	19.9	24.9	25.1	1.3
Vasopressin, U/h	2	2	0	0	2	2
Noradrenaline, μg/min	3	18	0	0	10	3

[a]Minimum for pH and base excess and maximum for all other variables.
ALP, alkaline phosphatase; ALT, alanine transaminase; GGT, gamma-glutamyl transferase; NR, not reported.

TABLE 2.

Recipient demographic and clinical characteristics and posttransplant outcomes

Variable	Recipient 1	Recipient 2
Age, y	42	54
Sex	Female	Female
Body mass index, kg/m^2	20.9	34.3
Diagnosis	Autoimmune hepatitis	NASH
MELD-Na score	20	22
Waiting time, d	367	11
Warm ischemia time,[a] min	41	43
Arterialization time,[b] min	52	55
Duration of surgery, min	460	445
Peak ALT, IU/L	395	1,169
Time to normal INR, d	1	4
White cell count,[c] ×10^9/L	7.3	11.1
Complications	Cystic stump leak	Nil
ICU stay, d	4	3
Hospital stay, d	27	18

[a]Time from liver out of ice to reperfusion.
[b]Time from reperfusion to artery open.
[c]Median during first week posttransplant
ALT, alanine transaminase; ICU, intensive care unit; INR, international normalized ratio; MELD-Na, model for end-stage liver disease-sodium; NASH, nonalcohol-related steatohepatitis.

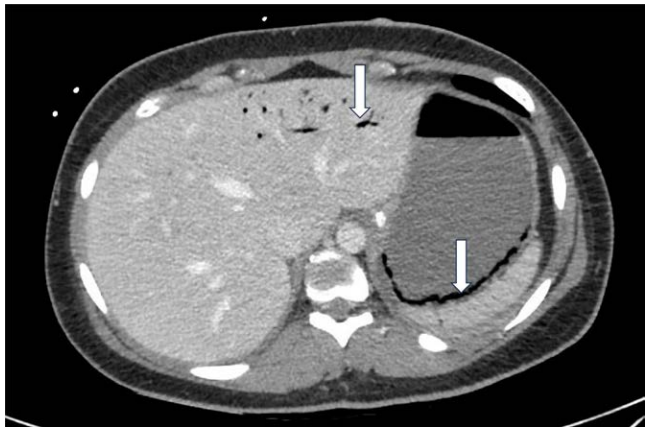

FIGURE 1. Portal venous phase of the CT scan performed 2 d before procurement in donor 1 showing intramural gas in the stomach and peripheral distribution of portal venous gas (both marked with arrows). CT, computed tomography.

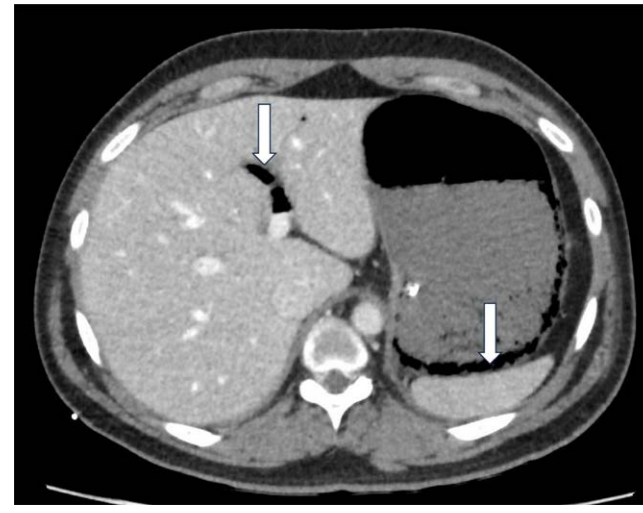

FIGURE 2. Portal venous phase of the CT scan performed 1 d before procurement in donor 2 showing intramural gas in the stomach and gas within the left portal vein (both marked with arrows). Other slices showed peripheral distribution of portal venous gas. CT, computed tomography.

hepatectomy was performed with a fresh thrombus partially occluding the recipient portal vein removed during hepatectomy with good portal venous flow. The donor liver was implanted using a piggyback LT technique. Standard triple immunosuppression (tacrolimus, prednisolone, and azathioprine) was used. She was transferred from the intensive care unit on postoperative day (POD) 4. On POD 7, the recipient was found to have a bile leak from the cystic duct stump, for which endoscopic sphincterotomy was performed and a biliary stent was inserted. The patient became febrile and tachycardic on POD 12 and was commenced on ceftriaxone and metronidazole. A CT scan of the abdomen and pelvis on POD 14 revealed a biloma around the porta hepatis and inferior vena cava anastomosis, for which a percutaneous drain was inserted and fluid aspirated. Aspirated fluid grew *Citrobacter freundii* and the patient was transitioned to ciprofloxacin and metronidazole. The patient recovered, had no further fevers, and was discharged home on POD 27. At 1 y posttransplant, she remains well with no further complications.

Recipient 2 was a 54-y-old woman with nonalcohol-related steatohepatitis. Vancomycin and piperacillin/tazobactam were administered on induction of anesthesia, which continued for 5 d postoperatively. Routine hepatectomy and piggyback LT were performed. Standard triple immunosuppression (tacrolimus, prednisolone, and mycophenolate mofetil) was used. She was transferred from the intensive care unit on POD 3. She remained afebrile throughout her admission and was discharged to the rehabilitation unit on POD 18. At 6 mo posttransplant, she remains well with no complications.

DISCUSSION

The underutilization of donor organs, especially in LT, remains a significant issue, owing to meticulous donor assessment to improve perioperative outcomes.[4,5] PVG is a concerning radiological sign that has been known to be associated with catastrophic pathology and mortality rates as high as 75% in a review by Liebman et al in the late 1970s, although more contemporary studies have demonstrated mortality to be closer to 40%.[6,7] Causes of PVG can be summarized as ischemic events, including hypoperfusion and thromboembolism (43%), inflammatory conditions (24%), bowel obstruction (18%), and miscellaneous (17%).[6] Management may involve a conservative approach with bowel rest and medical management, with escalation to exploratory surgical intervention, which may be warranted with case-by-case discretion.[6] It has been postulated that the underlying pathophysiology involves disruption to the layers of the intestinal wall, such as in intestinal ischemia, inflammatory bowel disease, or infection by gas-forming bacteria, leading to gas extravasation through the wall.[8] Given the significant pathology that can precipitate PVG, it is unsurprising that PVG in the donor liver has typically contraindicated transplantation due to concerns of allograft infection and potential for poor graft function. Indeed, an assessment of the literature to date does not yield any citations explicitly using donor livers with PVG for organ transplantation, demonstrating this contraindication.

The cause of PVG in the donors described in this report likely relates to a period of cardiac arrest. This could have resulted in transient gastrointestinal ischemia, followed by translocation of gas and/or gas-forming organisms into the portal venous system. There was evidence of gastric mural gas on a CT scan and PVG in both cases. When considering the suitability to proceed to organ procurement, our concern was not with the function of the grafts because the donors were young, brain dead, and had acceptable liver function tests and hemodynamic parameters at the time of organ offer, but with the potential for transmission of sepsis. The decision to proceed to organ procurement was conclusively made in the setting of satisfactory liver function, with resolution of ischemic hepatitis in donor 2 and lack of evidence of uncontrolled infection in either case. Care was taken at the time of procurement to ensure that there was no evidence of ischemia or sepsis and that both donors and recipients received broad-spectrum antibiotics, as usual. There were no donor or post-reperfusion biopsies in either case because they were not thought to be indicated in these cases.

Although there is a tendency to avoid extended criteria donors because of the perception of poorer posttransplant outcomes, transplantation of livers from these donors can result in similar graft outcomes to standard criteria donors and acceptance of such organs results in greater organ utilization.[9] Patients with a model for end-stage liver disease score of >17 have a survival benefit of transplantation with high donor risk index (>1.65) donor livers over continuing to wait.[10] Accepting rather than declining Public Health Service increased risk donors (those considered to be at increased risk of transmission of infectious diseases) livers is associated with better intention-to-treat survival.[10]

Ultimately, when considering the contemporary literature illustrating the greater presence of benign PVG causes (and successful conservative management thereof) and this report describing the successful transplantation of livers with PVG, it is reasonable to suggest that, with careful evaluation of the donor's clinical presentation and organ assessment at procurement, donors with PVG can be used for LT. This could enable greater utilization of donor resources in the setting of an imbalance between organ supply and demand.[9,10]

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