Transplant International ISSN 0934-0874

ORIGINAL ARTICLE

Liver transplantation with preservation of the inferior vena cava in case of symptomatic adult polycystic disease

Jan Lerut,[1] Olga Ciccarelli,[1] Matthieu Rutgers,[1] Giuseppe Orlando,[1] Jules Mathijs,[1] Etienne Danse,[2] Eric Goffin,[3] Jean-François Gigot[1] and Pierre Goffette[2]

1 Department of Abdominal transplantation, hepatobiliary and endocrine surgery, Liver Transplant Program, Cliniques Universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium
2 Department of Radiology, Liver Transplant Program, Cliniques Universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium
3 Department of Nephrology, Liver Transplant Program, Cliniques Universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium

Keywords
liver transplantation, polycystic liver disease, surgical technique, vena cava preservation.

Correspondence
Prof. Jan P. Lerut MD PhD, Department of Digestive Surgery, Cliniques Universitaires St-Luc/1400, Université catholique de Louvain (UCL), Av. Hippocrate 10, 1200 Brussels, Belgium. Tel.: 00-32-2-764.53.06; fax: 00-32-2-764.90.39; e-mail: lerut@chir.ucl.ac.be

Received: 23 December 2003
Revised: 8 July 2004
Accepted: 14 October 2004

doi:10.1111/j.1432-2277.2005.00061.x

Summary

Adult polycystic liver disease (APLD) is a rare disorder of the liver parenchyma, the treatment of which is still controversial. Conservative surgery may have a significant morbidity and is often ineffective in the long run. Liver replacement may be indicated in case of incapacitating hepatomegaly. Patients (one male, five females) undergoing liver transplantation for symptomatic APLD is presented in this study. The particular nature of this series is the fact that successful transplantation was performed in all cases with preservation of the recipient's inferior vena cava and without use of veno-venous bypass despite massive hepatomegaly and previous extensive liver surgery (in three cases). There was minimal morbidity and no mortality. All patients have excellent quality of life with a median follow-up of 41 months (range: 12–58) as testified by a median Karnofsky score of 90% (range: 80–100%).

Introduction

Adult polycystic liver disease (APLD) is a rare indication for orthotopic liver transplantation (OLT) as liver function is usually preserved[1].

Symptomatic patients mostly undergo extensive cyst fenestration (LIN operation) and some even hepatic resection. Both interventions have significant morbidity and long-term palliation is frequently insufficient as a result of cyst regrowth [1,2].

As a result of the formidable progress that has been made in the last decade, liver transplantation (LT) has been more frequently applied as a radical approach to this disease. LT is considered difficult or even hazardous of the huge hepatomegaly with accompanying englobement of the inferior vena cava (IVC) and because of the eventual previous liver surgery.

A series of six successful transplants performed with preservation of the recipient's IVC and without use of veno-venous bypass is reported.

Material and methods

Between February 1984 and June 2003, five females and one male adult (six of 557 patients, 1%) underwent OLT for incapacitating diffuse (type III) APLD [2] (Fig. 1). Their characteristics are summarized in Table 1. One male patient had isolated APLD. Median age was 40.4 years (range: 33–51). Three patients had extensive fenestration 2.5 and 4, 6 and 11 years prior to LT. Despite major liver volume reduction, confirmed by comparison of pre- and postfenestration volumetry, both patients became symptomatic again and asked for a 'radical solution' because of their extremely impaired quality of life. One patient presented with bile duct obstruction because of pigmented bile stones; she had undergone several surgical and endoscopic treatments (Table 1).

Median pretransplant creatinine clearance in the five patients presenting with hepatorenal disease was 87 ml/min/1.73 kg (range: 18–130). One patient with a

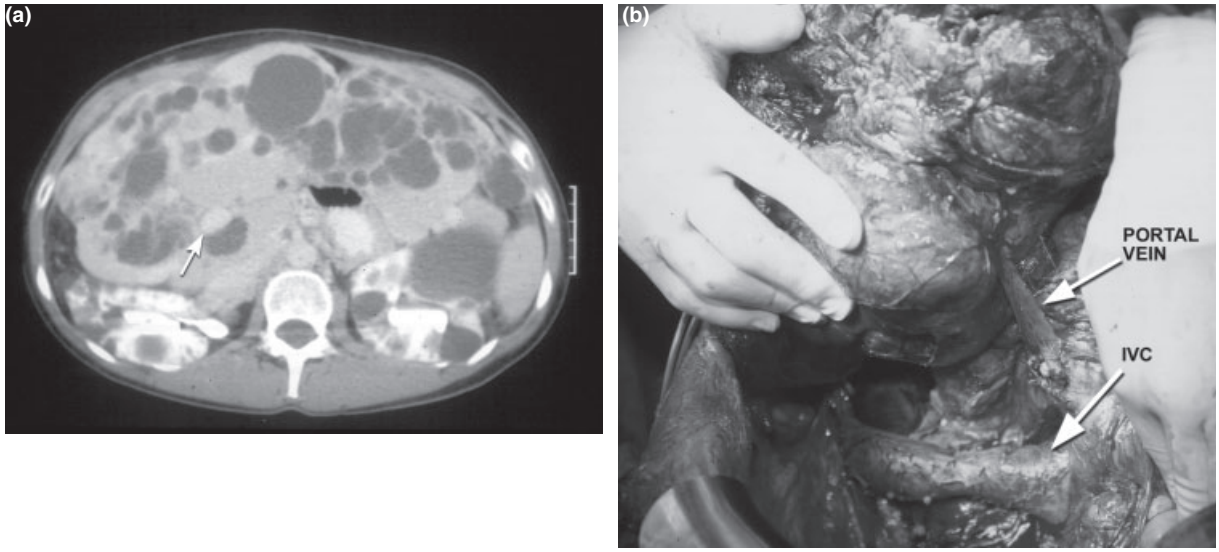

Figure 1 (a) CT-scan and cavography showing englobement of IVC by huge liver cysts. (b) Corresponding intraoperative view showing complete liberation of the recipient's IVC.

clearance of 18 ml/min, had combined liver–kidney transplantation.

Follow-up was complete for all patients ranging from 12 to 58 months (median 41).

Surgical technique

After performing a classical Mercedes type incision, the horizontal part of which is just above the umbilicus, the structures of the liver hilum are dissected [3]. Bile duct and hepatic artery are successively transected; the portal vein is skeletonized until the pancreatoduodenal venous branch.

In order to mobilize the liver as much as possible, extensive cyst fenestration is carried out to obtain better access to the retrohepatic and suprahepatic IVC. The infrahepatic IVC is always individualized in order to allow cross-clamping when necessary. None of the patients had a supradiaphragmatic approach to the IVC. All small hepatic veins, draining the right and caudate lobes of the liver, are ligated and transected from below upwards. This step which is usually difficult because of the modification of the hepatic parenchyma, is rendered easy by using intraoperative ultrasound (US) guided cyst fenestration. The right hepatic vein is transected using the endovascular stapler (Endo-GIA, Ethicon; Johnson & Johnson, Cincinnati, OH, USA). At the very last moment of the hepatectomy, the portal vein is cross-clamped and the cuff of the middle and left hepatic veins is stapler transected. Too much traction on the huge liver specimen should be avoided in order to prevent tearing of the hepatic veins.

The allograft is implanted using one large cavo-caval anastomosis between posterior and anterior wall of the donor and recipient IVCs. Portal vein, hepatic artery and biliary anastomoses are performed in a standard manner.

Results

The intraoperative data of the transplanted patients are summarized in Table 1. Median duration of surgery was 500 min (range: 350–900). Median warm ischemia time was 36 min (range: 26–38). Median intraoperative blood loss was 780 ml (range: 0–1589); only two patients needed blood allotransfusion. Infrahepatic IVC cross-clamping was necessary in four cases (median: 16.5 min; range: 10–20), veno-venous bypass was not used. Transplant surgery was very difficult in the three cases that had previous fenestration and omentoplasty; partial resection of the right diaphragm was necessary in one case.

The median 'dry' weight of the excised livers was 5012 g (range: 3950–10 000). This weight underestimates the real volume of the liver at the moment of LT as large amounts of fluid were evacuated intraoperatively, using extensive cyst fenestration and punction.

The liver volume in all three patients who had previous surgery had become greater than the estimated volume measured by CT scan volumetry after their extensive fenestration.

Early postoperative recovery was smooth in all patients. Median postoperative ventilatory support was 5.5 h (range:

Table 1. Characteristics of six patients undergoing liver transplantation because of adult polycystic liver disease (APLD).

OLT patients	1	2	3	4	5	6
Age (years)	44	51	37	37	33	55
Previous fenestration	No	Yes (11 years)	Yes (6 years)	No	No	Yes (4 and 2.5 years)
Indication	Abdominal distension; severe physical handicap	Fatigue; cholestasis (bile duct obstruction)	Abdominal pain; severe physical handicap	Abdominal distension; fatigue and pain	Abdominal distension; severe physical handicap	Abdominal distension; severe physical handicap
Renal polykystosis	Yes	Yes	Yes	Yes	Yes	No
Surgical/technique		Combined L–K T				
IVC preservation	Yes	Yes	Yes	Yes	Yes	Yes
Cavo-caval anastomosis	Yes	Yes	Yes	Yes	Yes	Yes
IVC cross-clamping (min)	Yes (15)	Yes (18)	Yes (10)	No	No	Yes (20)
'Dry' liver weight (g)	10 000	5600	4800	5225	3950	4310
Duration of surgery (min)	350	420	810	460	450	900
Ischemia time (min)						
Cold	527	414	755	582	637	966
Warm	35	26	37	38	35	37
Total	562	430	792	620	672	1003
Intraoperative blood product use (ml)						
Blood	0	0	750	0	913	0
Cell saver	865	0	692	478	1484	1589
SSPP	2000	3200	7000	2400	2800	3200
Artificial ventilation (h)	6	12	7	0	0	5
Stay						
ICU (days)	1	2	1	1	1	3
Hospital (days)	17	16	13	12	14	21
Postoperative complications	Refractory ascites because of MHV and IVC stenosis, requiring stenting (d37); CMV infection	MMF related diarrhea (d12)	None	Extrahepatic biliary stenosis; hepatico-jejunal anastomosis (d310); duodenal ulcer (d515)	Extrahepatic biliary stenosis; hepatico-jejunal anastomosis (d447); incisional hernia repair	Wound infection; thoracic drainage
Follow-up (months)	58	58	48	34	34	12
WHO status	1	1	1	1	1	1
Karnofsky index (%)/WHO status*	90/1	90/1	100/1	90/1	80/1	90/1
Immnunosuppression	TAC + MMF	TAC + MMF	TAC	TAC	TAC	TAC

OLT, orthotopic liver transplantation; L–KT, liver–kidney transplantation; ICU, intensive care unit; MHV, median hepatic vein; MMF, mycophenolate mofetil; IVC, inferior vena cava; TAC, tacrolimus; SSPP, state solution plasma proteins. *World Health Organisation.

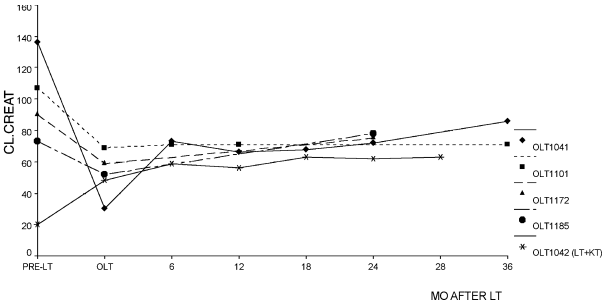

Figure 2 Evolution of measured creatinine clearance following LT in adults presenting polycystic hepatorenal disease.

0–12). Median intensive care unit and hospital stays were 1 (range: 1–3) and 15 days (range: 12–21).

No patient had pleural effusion or pulmonary infection. One patient developed refractory ascites. Doppler-US and transjugular, hepaticocaval, venography revealed a stenosis of the middle hepatic vein as well as a 3 mmHg gradient at the cavo-caval anastomosis. The ascites resolved after endovascular metallic stenting of both venous structures. Immunosuppression (IS) in all isolated LT consisted of tacrolimus (Prograft®; Fujisawa, Osaka, Japan) and, low-dose, short-term (64 days) steroids. Subtherapeutic (<6 ng/ml) tacrolimus blood trough levels were aimed at IS was temporarily reinforced in one case with mycophenolate mofetil (MMF) (Cellcept®; Roche, Basel, CH) because of hepatic allograft rejection. The liver–kidney recipient received triple IS based on tacrolimus, low-dose steroids and MMF-based IS.

In all patients, creatinine clearance improved after a median follow-up of 41 months (range: 12–58), despite the (cautious) use of nephrotoxic IS (Fig. 2). Psychological and physical health status dramatically improved (median Karnofsky score of 90%, range: 80–100; WHO status of one in all patients). Indeed all patients were very pleased with the transplant procedure and regretted not having taken the transplant decision earlier.

Discussion

Liver transplantation is an infrequent therapeutic option for APLD. Indeed, this rare autosomal dominant disorder is characterized by well preserved liver function [1]. However, quality of life can be severely impaired with huge hepatomegaly causing abdominal distension, pain, dyspepsia, dyspnea, fatigue, physical and even psychological handicap. Moreover, progressive 'recurrent' disease is frequently reported even after extensive conventional liver–cyst surgery. It should be underlined that morbidity and mortality of conservative liver surgery is high (40% and 15%, respectively) [1].

Recent surgical and medical progress has clearly changed the attitudes toward this disease [4–7]. Several series including five or more patients have been published during the last decade [8–14] (Table 2). Early morbidity and mortality of LT for APLD, reaching 36% and 17%, respectively, are mainly because of pulmonary, infectious and hemorrhagic complications. Total hepatectomy can be hazardous, especially after previous extensive fenestration, as a result of tight scar formation between diaphragm, stomach, spleen, colon, omentum and fenestrated cysts. Repeated conservative liver surgery and especially extensive omentoplasty should be abandoned in view of possible later LT. Wrapping the fenestrated liver with omentum makes the transplant procedure almost impossible.

The particular nature of this series is because of the fact that hepatectomy was always successfully performed with preservation of the recipient's IVC, without use of veno-venous bypass and without total clamping of IVC. The IVC is only clamped temporarily beneath the liver in order to reduce tension and thus faclitate ligation of the Spigelian veins. Portal vein is only clamped at the very last moment of hepatectomy, a maneuver which is of importance in patients who do not have portal hypertension. In order to facilitate IVC exposure and preservation, US-guided fenestration is used; this maneuver makes the approach to the IVC easier and also allows for lower hepatic venous congestion thus contributing to less intraoperative blood loss. The short artificial ventilation time, intensive care and hospital stays of our patients reflect the importance of such a surgical strategy.

Transplantation for a benign, nonlife threatening liver disease such as APLD can be justified only if morbidity and mortality are lower after conventional surgery and if long-term quality of life is excellent. Such results can now be achieved by combining meticulous transplant surgery, reduction of the perioperative blood product use and judicious use of IS. The strategy of steroid avoidance and low-dose tacrolimus monotherapy is of particular value in this context, especially when the patients present a hepatorenal cystic disease. It should be remembered that LT by itself improves renal function [14].

Liver transplantation should be considered as a valid therapeutic option in patients presenting with symptomatic polycystic liver disease, if the adapted surgical technique and tailored IS are taken into account. Unfortunately, these patients are badly served by the liver allocation system based on model end-stage liver disease (MELD) score because of the absence of liver insufficiency. In view of the encountered intraoperative difficulties (redo)conservative liver surgery should be abandoned in favor of the more radical transplant procedure.

Table 2. Literature review of liver transplantation (LT) carried out because of adult polycystic liver disease.

Reference	*n*	Sex (f/m)	Age (years)	Previous surgery	Combined L–KT	Surgical technique	Median liver weight (g)	Postoperative medical	Morbidity surgical	Mortality (<3 months)
Kwok and Lewin [4]	1	1/0	51	1	1	NA	7700	–	Bleeding 1 (+)	1 intraoperative bleeding
Starzl *et al*. [5]	4	4/0	44 (37–57)	2	2	Classical	7087 (4000–12 900)	Psychosis 1; pneumonia 1; HBV graft infection 1 (+)	Bleeding 1; early re-LT for graft dysfunction 1	
Taylor *et al*. [6]	1	1/0	47	1	1	Classical	5185	Pulmonary embolism 1; urinary infection 1	–	–
Mc Peake and Portmann [8]	8	8/0	NA	NA	3	NA	NA	NA	Bleeding 1	1 intraoperative bleeding; 1 sepsis (1 month)
Fan *et al*. [7]	2	1/1	57 (55–59)	NA	NA	Classical	NA	Urinary infection 1	NA	1 PNF
Klupp *et al*. [9]	10	8/2	50 (39–58)	3	5	NA	10 555 (2550–23 000)	Cholangitis 2, pneumonia 1, late pulmonary embolism because of deep venous thrombosis 1, CMV infection 1, urinary infection 1, renal failure 2	Multiple bleeding 1 (+)	1 bleeding; 1 pulmonary insufficiency and MOF
Washburn *et al*. [10]	5	4/1	47 (38–57)	4	1 (1 KT after LT)	Classical	7112 (3213–10 500)	–	Bleeding 1 (+)	1 intraoperative bleeding
Lang *et al*. [11]	17	16/1	47 (23–63)	6	8	NA	8350 (3200–22 250)	Toxic lung failure requiring single lung transplantation 1	Early re-LT (HAT-PNF) 2, bleeding 4, biliary leakage 2, gastric perforation 1, colon perforation 1(+), splenic rupture 1, rupture suprahep IVC 2, rupture right atrium 1	
Jeyarajah *et al*. [12]	6	5/1	47 (36–60)	5	3 (2 KT after LT)	NA	7087 (2700–11 560)	–	–	1 candida sepsis
Swenson *et al*. [13]	9	8/1	50 (42–62)	4	3	Classical	NA	Myocardial infarction, sepsis 1 (+)	Re-LT (HAT) 1, bleeding 1, biliary leak 1	1 sepsis MOF
Pirenne *et al*. [14]	16	16/0	45 (34–56)	4	1 (1 KT after LT)	Classical	(10 000–20 000)	Pneumothorax and subphrenic collection 1, pneumonia 1, CMV infection 1, de novo HBV hepatitis 1	Biliary stricture 2, bleeding 1, bleeding and air embolism1 (+)	1 bleeding
UCL (2003)	6	5/1	40 (33–55)	3	1	Cavo-caval anastomosis; IVC preservation	5012 (3950–10 000)	Diarrhea 1, CMV infection 1, duodenal ulcer 1	MHV and caval stenosis 1, biliary stenosis 2, wound infection 1	
Total	85	77/8 (90.6%)	48 (23–62)	33 (38.8%)	29 (34.1%)		(2700–22 250)	23 (27%)	31 (36.5%)	15 (17.6%)

L–KT, liver–kidney transplantation; PNF, primary nonfunction; HAT, hepatic artery thrombosis; MOF, multiple organ failure; MHV, median hepatic vein; NA, not available.

Acknowledgements

This study was in part supported by grand FRSM no. 3.4548.02.

References

1. Vauthey JN, Maddern GJ, Blumgart LH. Adult polycystic disease of the liver. *Br J Surg* 1991; **78**: 524.
2. Gigot JF, Jadoul P, Que F, *et al.* Adult polycystic liver disease. Is fenestration the most adequate operation for long-term management? *Ann Surg* 1997; **225**: 286.
3. Lerut J, Ciccarelli O, Roggen Fr, *et al.* Cavo-caval adult liver transplantation and retransplantation without veno-venous bypass and without porta-caval shunting: a prospective feasibility study in adult liver transplantation. *Transplantation* 2003; **75**: 1740.
4. Kwok MK, Lewin KJ. Massive hepatomegaly in adult polycystic liver disease. *Am J Surg Pathol* 1988; **12**: 321.
5. Starzl TE, Reyes J, Tzakis A, Mieles L, Todo S, Gordon R. Liver transplantation for polycystic liver disease. *Arch Surg* 1990; **125**: 575.
6. Taylor JE, Calne RY, Steward WK. Massive cystic hepatomegaly in a female patient with polycystic kidney disease treated by combined hepatic and renal transplantation. *Q J Med* 1991; **81**: 771.
7. Fan ST, Lo CM, Chan KL, *et al.* Liver transplantation – perspective from Hong-Kong. *Hepatogastroenterology* 1996; **43**: 893.
8. Mc Peake A, Portmann B. Hepatic malignancy, Budd-Chiari syndrome and space-occupying condition. In: Williams R, Portmann B, Tan KC, eds. *The Practice of Liver Transplantation*. New York: Churchill Livingstone, 1995: 57–68.
9. Klupp J, Bechstein WO, Lobeck H, Neuhaus P. Orthotope lebertransplantation zur therapie der fortgesschrittenen polycystischen lebererkrankung. *Chirurg* 1996; **67**: 515.
10. Washburn WK, Johnson LB, Lewis WD, Jenkins RL. Liver transplantation for adult polycystic liver disease. *Liver Transplant Surg* 1996; **2**: 17.
11. Lang H, Von Woellwarth JV, Oldhafer KJ, *et al.* Liver transplantation in patients with polycystic liver disease. *Transplant Proc* 1997; **29**: 2832.
12. Jeyarajah DR, Gonwa TA, Testa G, *et al.* Liver and kidney transplantation for polycystic disease. *Transplantation* 1998; **66**: 529.
13. Swenson K, Seu P, Kinkhabwala M, *et al.* Liver transplantation for adult polycystic liver disease. *Hepatology* 1998; **28**: 412.
14. Pirenne J, Aerts R, Gunson B, *et al.* Surgical strategy in liver transplantation for polycystic liver disease. *Liver Transplant* 2001; **7**: 238.