Experience with living related liver transplantation in 63 children

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Abstract

The incentive to develop intrafamilial living related liver transplantation (LRLT) originated from the shortage of cadaveric organ supply. We report our experience with LRLT in 63 children during 1993-1998 in the frame of a protocol approved by the Ethics Committee of our Institution.

During this period, 152 potential intrafamilial (mostly parental) donors were evaluated ; 44 (28,5%) were excluded because of surgical (n = 4), medical (n = 39) or psychosocial reason (n = 1). Out of 108 who matched all medical, surgical and psychological criteria of selection, 45 did not underwent living donation because their child received a cadaveric graft (n = 22 ; LRLT was their second option) or because one of the parents who had both been selected was chosen [by the surgical team because of more favourable anatomy (n = 8) or by mutual agreement between the two parents (n = 5)]. Sixty-three living donors (36 mothers, 24 fathers, one grand mother, one aunt and one uncle) underwent procurement of the left lobe (n = 52), the left lobe extended to part of segment IV (n = 8) or a left hepatectomy (n = 3) without mortality or any serious morbidity. Their median hospital stay was 7 days (range : 6-12) ; full physical rehabilitation and normalization of liver tests were usually obtained within three weeks. Their psychological follow-up did not disclose any longstanding serious sequellae.

The median age of the recipients was 13 months (range 5-189) ; 30 were younger than one year at the time of transplant. Their median weight was 8,1 kg (range : 4,3 to 60) ; 36 had an actual weight under 10 kg. Fifty-two received an ABO identical and 11 received an ABO compatible transplant.

The native liver diseases were similar to common data in children, with biliary atresia being the most frequent indication (74,6%). The median weight of the graft was 260 gr (range : 138-680) with a median ratio between the graft weight and the recipient body weight of 3,17% (range : 0,75-8,08). All grafts were implanted orthotopically with semi-microvascular reconstruction of the hepatic vein, portal vein and hepatic artery [end to end anastomosis in 58 (2 arteries were reconstructed in 7 patients) and interposition of an iliac arterial allograft from the infrarenal aorta in 5].

Base line immunosuppression consisted of a triple drug regimen including steroids, Azathioprine and either Cyclosporine-Sandimmun® (n = 9), Cyclosporine Microemulsion formulation - Neoral® (n = 13) or Tacrolimus - Prograft® (n = 41). Biopsy-proved acute rejection was treated with intravenous bolus of steroids ; steroid-resistant acute rejection was treated by a switch from Cyclosporine to Tacrolimus or addition of Mycophenolate-Mofetil (Cellcept®) in Tacrolimus treated patients.

Actuarial patient survival was 91,8% and 89,6% after LRLT at one and five years post-transplant, respectively, and 87,5% and 82,8% at one and five years, respectively, in 90 patients who received a cadaveric graft during the same interval. Actuarial graft survival was 91,8% and 84,1% after LRLT at one and five years, respectively, and 76,4% and 73,3% at one and five years, respectively, after cadaveric transplants.

Vascular thrombosis was observed in 9,5% of the patients (arterial thrombosis : 1,6% ; portal thrombosis : 7,9%) without graft loss. Biliary complications were observed in 26,9% (bile leak from cut surface in 3,1%, anastomotic stricture in 22,2% and intrahepatic stricture in 1,5%) ; two patients died from septic shock possibly related to uncompletely relieved anastomotic stricture ; all other biliary complications were successfully treated either conservatively or surgically.

The incidence of acute rejection was 90,9% in 22 patients with Cyclosporine-based immunosuppression ; acute rejection was corticoresistant in 50%. It was 46,3% in 41 patients with Tacrolimus-based immunosuppression (64% with Prograft® in capsules and 18,7% with Prograft® in granules) ; no acute rejection was corticoresistant. One patient in each group developed chronic rejection (in spite of switch to Tacrolimus in a patient initially treated with Cyclosporine and following full withdrawal of immunosuppression for posttransplant lymphoproliferation in a patient immunosuppressed with Tacrolimus) ; both patients were successfully retransplanted with a cadaveric graft.

The incidence of posttransplant lymphoproliferative disorder was 14,2% and similar whatever the main immunosuppressant (13,6% in the Cyclosporine group and 14,6% in the Tacrolimus group). One of the 9 patients with PTLD died of uncontrolled disease.

In conclusion, clear ethical guidelines in the frame of a protocol approved by the Institution Ethics Committee should be followed in living related liver transplantation. Safety for the donor should be maximized ; extensive surgical expertise with all types of liver resection and transplants including split grafts is a prerequisite. Results regarding patient and graft survival are superior to those obtained with cadaveric transplants. Implementation of LRLT in expert teams is a valid way to obviate the shortage of cadaveric transplants. (Acta gastroenterol. belg., **1999**, 62, **355-362**).

Key words : liver, liver transplantation, living liver donation, liver diseases, children.

Introduction

The incentive to develop intrafamilial living related liver transplantation (LRLT) originated from the shortage of cadaveric organ supply (1,2,3,4). Indeed, about two thirds of the children listed in our center are younger than 3 years and have a weight beneath

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12 Kg (5). Their number exceeds by far the number of size matched pediatric donors. The development of innovative techniques allowing the transplantation in children of a part of an adult donor liver (reduced — cut-down or partial grafts, split grafts) has helped temporarily to decrease their mortality rate on the cadaveric waiting list (6,7,8). The plateauing of the number of available cadaveric donors and the ever increasing demand for adult recipients led the pediatric transplant centers to implement transplantation from live parental donors (1,2,9,10).

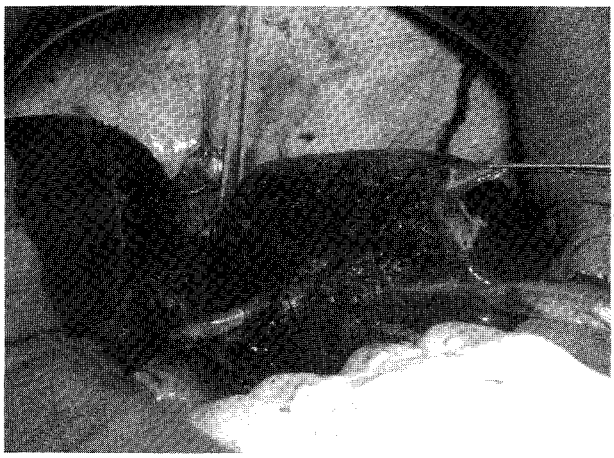

Fig. 1. — Operative view of the procurement of the left lateral segment (Couinaud's segments II and III) from a living donor after completion of parenchymal transsection : the left hepatic vein is encircled by a blue vessel loop (upper part) ; the round (umbilical) ligament and falciform ligament (hold by a forceps) remain attached with the left lateral segment. The left hepatic duct (→) has been transsected, the left portal vein (⇒) and the left hepatic artery (➔) have been dissected free on their full length.

The surgical concept consists of combining two operations (2,11), which are both well mastered. In order to minimize the risk to the donor, liver resection (fig. 1) is usually limited to the left lobe (Couinaud's segments II and III) or the left hemiliver (including segment IV) depending on the weight of the pediatric recipient (12). The recipient undergoes excision of his/her native liver followed by orthotopic implantation of the liver graft, according to the same technique as for a left segmental cadaveric liver transplant (13,14).

Our views on the ethical and legal aspects have been developed elsewhere (15,16). We developed a protocol which was approved in 1992 by the Ethics Committee of our institution and revisited in 1996. We report our experience with 63 LRLT's performed between July 1993 and September 1998. The patient and graft survival rates were compared to those of 90 children who received a first cadaveric graft during the same interval.

A. DONORS

Patients, methods and results

Donor population

During the period 1993-1998, 152 potential familial donors were evaluated by an internist not belonging to the transplantation team and by a psychologist, supervised by a psychiatrist. Of these 152, 108 matched all medical and psychological criteria of selection. Of these 108, 63 underwent liver donation while 45 did not. Among this latter group, 22 had chosen the option to first register their child on the cadaveric waiting list and to proceed to donation should his/her condition deteriorate before getting a cadaveric transplant ; actually, these 22 children received a cadaveric graft. In 13 pairs of parents who were both fit for donation, one was chosen because of a more favourable anatomy in 8 cases ; in 5 cases, the parents decided between themselves who would donate. The remaining 10 potential donors did not undergo procurement for various reasons [recipient on unactive waiting list (n = 5), recovery of the recipient under medical treatment (n = 3), death of the recipient before LRLT (n = 1), recipient excluded for medical contraindication (n = 1)].

Forty-four (28,5%) potential donors were excluded because of surgical [too small left lobe (n = 2), left lobe hemangioma (n = 1), multiple left hepatic arteries (n = 1)], medical (n = 39) or psychosocial contraindication (n = 1) (table I)]. The main medical contraindications were anti-HBc positivity, steatosis of the liver and obesity.

Table I. — **Assessment of 152 potential living donors**

Medical contraindication		**39**
Anti-Hbc (+) ve	9	
Steatosis	8	
Obesity	7	
Abnormal liver enzymes	4	
ABO incompatibility	2	
Haematologic disorder	2	
Cardiac arythmia	2	
HCV (+) ve	2	
Cross match (+) ve	1	
Heavy smoker	1	
Pregnancy	1	
Psychosocial contraindication		**1**

The radiological assessment consisted of ultrasound for precise identification of the left and median hepatic veins (fig. 2), computed tomography for volumetry (fig. 3) of left lateral segment (Couinaud's segments II and III) and of segment IV (in case the full left lobe should be procured to obtain sufficient liver mass) and selective angiography of the coeliac trunk and, when indicated, of the superior mesenteric artery.

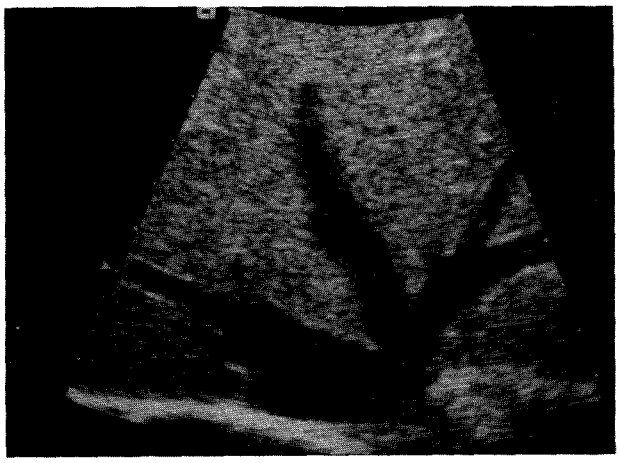

Fig. 2. — Ultrasound of the donor liver showing retrohepatic vena cava, left (LHV) , median (MHV) and right (RHV) veins.

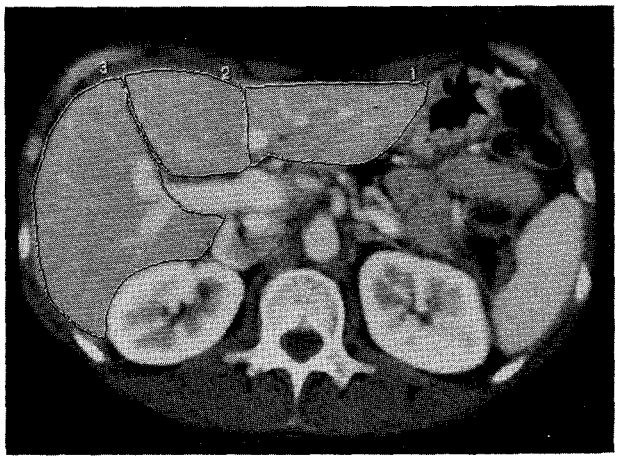

Fig. 3. — Computed tomography allowing volumetry of segments II and III, IV and right lobe (segments V to VIII).

Clinical course of 63 actual donors

There were 36 mothers, 24 fathers, one grandmother, one aunt and one uncle. The median age of parental donors was 33.1 years (range : 19-45) ; the grandmother was 54 years old. The extent of liver resection was a left lobectomy (n = 52), a left lobectomy extended to part of segment IV (n = 8) or a left hepatectomy (not including the median hepatic vein) (n = 3).

The median hospital stay was 7 days (range : 6-12). Postoperatively, a transitory disturbance of the liver tests was observed (median peak of 1.45 mg/dl for total bilirubine, of 234 IU/l for ALAT and of 61 IU/l for GGT). Minor surgical complications were encountered : biliary leakage from the cut surface with spontaneous healing (n = 4), incisional hernia needing repair(n = 4), transitory and infraclinical right pleural effusion (n = 2) and ulnar nerve compression (n = 1). Full physical rehabilitation and normalization of liver tests were usually obtained within three weeks.

Psychological follow-up. The donors were followed as closely as possible by a psychologist. Thirty-eight of 40 donors responded to a questionnaire. Follow-up was < 6 months in 5, between 6 and 12 months in 10, between 1 and 2 years in 19 and over 24 months in 5. The motivations to donate were love for their child (100%), escaping the Cornelian dilemna of waiting for the death of another person (35%), playing an active role in the child salvaging (30%), "completing" the project of giving life (30%). Retrospectively, 37% evoked increase selfconfidence, 55% a feeling of good luck to have been given the possibility to donate, 37% enhanced confidence in the medical team ; proudness and tightening of the familial links were underlined by 55%. Twenty-nine percent and 34% experienced transitory depression and a feeling of exaltation respectively ; most donors who mentioned these kinds of feeling were often the same. Every donor considered to have made the right choice and would do it again. Ninety-two percent would encourage other people to donate.

B. RECIPIENTS

Patients, methods and results

Recipient population

The native liver diseases were similar to common data in children (table II) (17,18). Noteworthily, the indication consisted twice each of severe hepatopulmonary syndrome (19) and fulminant liver failure. The 63 children had a median age of 13 months (range 5-189) ; 30 were younger than one year at the time of transplant. Their median weight was 8,1 Kg (range : 4,3 to 60), 36 had an actual weight under 10 Kg. Fifty-two received an ABO identical and 11 received an ABO compatible transplant.

Table II. — **Pretransplant diagnosis**

Pretransplant diagnosis	
Biliary atresia	47
Familial cholestasis	4
Cystic fibrosis	2
Fulminant liver failure	2
Subacute liver failure	1
Hepatopulmonary syndrome	2 *
Cryptogenic cirrhosis	2
Alagille syndrome	1
Cholestatic cirrhosis	1
Crigler-Najjar	1
Hepatoblastoma	1

* underlying disease : Biliary atresia — Histiocytosis X with sclerosing cholangitis.

Surgical techniques

The median weight of the graft was 260 gm (range : 138-680) ; median ratio between the graft weight and the recipient body weight was 3.17% (range 0.75 - 8.08).

All grafts were implanted orthotopically with a triangulation of the anastomosis between the left hepatic vein and the recipient vena cava (20). Portal reconstruction consisted of an end-to-end anastomosis (n = 41) or a jump ABO identical or compatible cadaveric venous iliac allograft implanted on either the splenomesenteric confluence (at the upper aspect of the pancreas ; n = 11) or the superior mesenteric vein (n = 9) (data not available in 2). In 58 cases, an end-to-end anastomosis was performed between the donor left hepatic artery and the recipient proper hepatic artery (2 anastomoses were done in 7 patients). An ABO identical or compatible cadaveric iliac arterial allograft was interposed between recipient infrarenal aorta and graft hepatic artery in 5 patients. Biliary drainage consisted of Roux-en-Y anastomosis (n = 62) or hepatico-choledochostomy (n = 1). Magnifying glasses (× 6) were routinely used for all vascular and biliary reconstructions. In 16 (23,4%) patients who received an extralarge graft, the abdomen was closed with a reinforced silastic prosthesis covered by skin ; this material was removed after a median of 11 days (range : 6-65) (21).

Immunosuppression

Base line immunosuppression (22,23,24) consisted of a triple drug regimen including steroids, Azathioprine and either Cyclosporine-Sandimmun® (n = 9), Cyclosporine microemulsion formulation - Neoral® (n = 13) or Tacrolimus - Prograft® (n = 41). Intravenous methylprednisolone therapy was started intra-operatively at a dosage of 10 mg/kg ; steroid dosage was subsequently tapered to reach 1 mg/kg/day at two weeks post-LRLT and 0,25 mg/kg/day at three months, with subsequent progressive switch to alternate day therapy. Azathioprine was given during the first six post-transplant months at an average dosage of 1.5 mg/kg/day, depending on platelet and white cell counts. Cyclosporine dosage was adjusted to maintain a trough level between 250-350, 100-250 and 50-100 ng/ml during the first six months, the second semester and beyond one year, respectively. Tacrolimus dosage was adjusted to reach trough blood levels between 10-15 ng/ml during the first post-transplant month, and 5-10 ng/ml thereafter. Biopsy-proved acute rejection was treated with intravenous Methylprednisolone bolus (10 mg/kg/day) for three days followed by a three-day scheme of "recycling" doses (7.5, 5 and 2.5 mg/kg/day). Steroid-resistant acute rejection was treated by a switch from Cyclosporine to Tacrolimus or addition of Mycophenolate-Mofetil (Cellcept®) in Tacrolimus (Prograft®) treated children.

Patient and graft survival rates were compared in 63 LRLT and in 90 patients who received a primary cadaveric transplant during the same period (1993-1998).

Actuarial patient survival was 91,8% and 89,6% after LRLT (n = 63) at one and five years post-transplant, respectively, and 87,5% and 82,8% at one and five years, respectively, after cadaveric transplant (n = 90) (fig. 4).

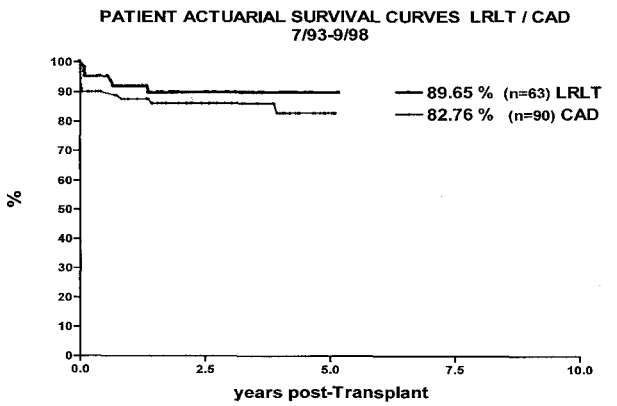

Fig. 4. — Actuarial patient survival curves comparing LRLT to cadaveric first transplant.

The actuarial patient survival related to UNOS clinical status of the recipients showed superior results (although not statistically significant due to small numbers) obtained for LRLT in all 3 categories (table III).

Actuarial graft survival was 91,8% and 84,1% after LRLT at one and five years, respectively, and 76,4% and 73,3% at one and five years, respectively, after cadaveric transplant (fig. 5).

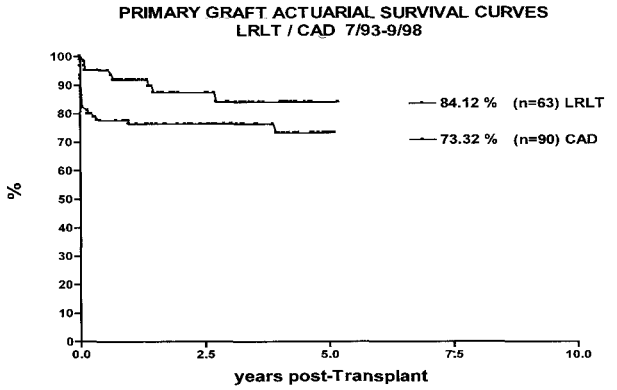

Fig. 5. — Actuarial graft survival curves comparing LRLT to cadaveric first transplant.

Table III. — **UNOS (United Network of Organ Sharing) Status (I : ICU-bound, II : hospital-bound, III : elective, at home)**

5-year actuarial patient survival according to type of first graft(%)				
UNOS Status	LRLT		Cadaveric list	
	n	survival	n	survival
1	3	100	12	50
2	27	80.45	14	69.84
3	33	93.63	64	94
	63	89.6	90	82.8

Causes of death

Seven (11,1%) patients who had received a LRLT died as well as 13 (14,4%) who had received a cadaveric graft ; causes of death are detailed in table IV. In the LRLT group, relapsing fulminant liver failure was observed in a 4,5 month old child who got his transplant for subacute liver failure of unknown origin ; sepsis possibly related to biliary stricture led to death of two patients ; a 13 year old child with cystic fibrosis who had received a small for size transplant (graft weight over recipient weight ratio = 1.03%) and developed portal thrombosis, died of graft failure.

In the cadaveric group, six patients died of arterial thrombosis (n = 3), portal thrombosis (n = 1) or primary non function (n = 2) before a graft could be found for retransplantation ; one child transplanted for autoimmune cirrhosis died postoperatively from untractable pulmonary hypertension which had not been detected before transplantation.

Table IV. — **Causes of death**

Living related liver transplants : 7 (11.1%)		
(n = 63)	Relapsing fulminant liver failure	1
	Posttransplant lymphoproliferative disorder	1
	Sepsis	2
	Graft failure	1
	Adenovirus	1
	Tumour recurrence	1
Cadaveric transplant : 13 (14.4%)		
(n = 90)	Arterial thrombosis	3
	Portal thrombosis	1
	Primary non function	2
	Chronic rejection	1
	Fungal infection	1
	Toxic shock	1
	Pulmonary hypertension	1
	Multiple organ failure	1
	Biliary sepsis	1
	Brain death	1

Table V. — **Causes of first graft-loss**

Causes of first graft loss		
Living related liver transplants		
9 (14.2%)	Patient's death :	7
(n = 63)	Chronic rejection :	2
Cadaveric transplants		
22 (24.4%)	Patient's death :	13
(n = 90)	Arterial thrombosis :	6
	Portal thrombosis :	1
	Primary non function :	2

Causes of graft loss (table V)

In the LRLT group, nine grafts (12,7%) were lost due to patient death (n = 7) and chronic rejection (n = 2, one after discontinuation of immunosuppression for PTLD and one despite intensified immunosuppression) ; both were successfully retransplanted with a cadaveric graft. Twenty-two (22,4%) cadaveric first transplants were lost due to patient death (n = 13), arterial thrombosis (n = 6), portal vein thrombosis (n = 1) or primary non function (n = 2) ; five patients with arterial thrombosis out of 6 were successfully retransplanted (see table IV).

Surgical and medical complications

In the LRLT group, vascular thrombosis was observed in 6 patients (9,5%) [one (1,6%) arterial thrombosis and 5 (7,9%) portal thrombosis either early (n = 3) or late (n = 2)] ; patency was restored in all cases with salvage of the graft (except the patient who died from graft failure due to a small for size graft complicated by preterminal portal thrombosis). In the cadaveric group, vascular thrombosis was observed in 7 (7,7%) [6 (6,6%) arterial thrombosis and one (1,1%) portal thrombosis] ; of these 7 patients, 5 were successfully retransplanted.

Biliary complications were frequent in the LRLT group (n = 17 - 26,9%) ; they consisted of biliary leak from cut surface or hilar plate in two needing surgical correction, anastomotic stricture in 14 (22,2%) (11 surgical repair, 3 percutaneous dilatation) and intrahepatic stricture in one treated by percutaneous dilatation. Two patients died from septic shock possibly related to uncompletely relieved anastomotic stricture. Other complications included posttransplant small bowel perforation (n = 5), intestinal obstruction (n = 1) and post-operative bleeding (n = 2) ; all 8 patients needed corrective surgery and survived as well as a patient transplanted for severe hepatopulmonary syndrome who developped a brain abscess (streptococcus milleri) which was surgically drained without sequellae.

Acute and chronic rejection

In patients with Cyclosporine-based immunosuppression, acute rejection was observed in 9 patients (100%) treated with Sandimmun® and 11 (85%) patients treated with Neoral®. Acute rejection was corticoresistant in 50% (10/20) ; these ten patients were switched to Prograft® as well as an 11th patient because of relapsing acute rejection. One (4.5%) patient developed chronic rejection and needed a cadaveric retransplant despite switch to Prograft®.

Out of 41 patients treated with Prograft® as primary immunosuppressant, 19 (46,3%) presented with acute rejection ; none was corticoresistant. One (2.4%) patient developed chronic rejection following full withdrawal of immunosuppression for PTLD and received a successful cadaveric retransplant. In patients with Tacrolimus-based immunosuppression, 25 received capsules, with an incidence of acute rejection of 64% (16/25) ; 16 patients received granules with an incidence of rejection of 18.7% (3/16) (see footnote).

Tacrolimus in capsules or granules was provided by Fujisawa (Osaka, Japan) in the scope of clinical trials.

Post-transplant lymphoproliferative disorder (PTLD)

Nine (14.2%) patients developed PTLD (25) which was controlled by full withdrawal of immunosuppression in eight (88,8%). One (11,2%) patient died of uncontrolled lymphoproliferation in spite of withdrawal of immunosuppression ; lymphoproliferation was controlled in another who died later of sepsis possibly related to uncompletely retrieved biliary stricture. In the Cyclosporine group, the incidence of PTLD was 13.6% (3/22) ; one patient had been previously switched to Tacrolimus for relapsing acute rejection and another one had received OKT-3. All three patients survived. Neoral® was restarted in one and was replaced by Cellcept® in one ; Prograft® (previous switch) was restarted in the third one. In the Tacrolimus group, the incidence of PTLD was 14,6% (6/41) ; two (33%) patients died but only one from uncontrolled lymphoproliferation. Four patients survived : very low dose of Prograft® was restarted in two, one was retransplanted under Prograft® for chronic rejection following complete withdrawal of immunosuppression while one was restarted on Cyclosporine-Neoral®.

Maintenance immunosuppression

As per May 15, 1999, 56 patients were alive ; their follow-up was shorter than one year in two and between one and six years in 54. Initial immunosuppression was Cyclosporine-based in 20 ; at latest follow-up, nine remained on Cyclosporine-Neoral® (with Mycophenolate-Mofetil - Cellcept® - in one), 10 had been switched to Prograft® (with Cellcept® in 2) and one had been switched to Cellcept® to control rejection after temporary withdrawal of immunosuppression because of PTLD. Eight of nine patients maintained on Cyclosporine-Neoral® were still receiving alternate days steroids as well as eight of nine patients switched to Tacrolimus.

Immunosuppression was Tacrolimus-based in 36 ; at latest follow-up, 33 were maintained on Prograft® and three had been converted to Neoral® because of suspected lymphoproliferation (with Cellcept® in one) ; 18 were still maintained on alternate days steroids.

Discussion

Implementation of LRLT in our program of paediatric liver transplantation required a profound reflection on the ethical aspects (15,16). Diverse ethical stakes were thoroughly discussed regarding the principles of utility (risks and benefits), autonomy (informed consent) and justice (equitable allocation of resources). These principles were considered from the viewpoint of both donor and recipient. A protocol similar to that of the Chicago group (1) was submitted to and accepted in 1992 by the Ethics Committee of our Institution ; another year passed before performing our first case (July 28, 1993) in order to be sure about the real needs of this procedure and to allow all teammembers to agree about the validity of the project. Ethical reflection was started again after our first 30 cases (26) and the revised protocol was submitted and approved by the Ethics Committee in 1996. It's modifications concerned release of information given to the parents of referred children about various kinds of liver transplant procedures (including LRLT), selection of donors (intrafamilial but extended to first degree relatives) and of recipients (beside elective patients with stable clinical condition, inclusion of children with fulminant liver failure, decompensated end-stage liver cirrhosis and retransplantation).

Potential donors are screened thoroughly and excluded if any factor increasing the operative risk is disclosed. Particular attention is payed to overweight and liver steatosis which played a role in one (27) of the two donors who died post-operatively out of more than 1000 cases worldwide.

By maximizing the safety of the donor (28), we did not observe so far any serious morbidity. Out of 152 potential donors who were evaluated, 40 (26,3%) were excluded because of medical (n = 39), surgical (n = 4) or psychological (n = 1) contraindications. With our current expertise, two donors excluded for surgical contraindication (double artery, hemangioma of the left lateral segment close to the left hepatic vein) would have been accepted.

The San Francisco group reported about their donor selection policy ; out of 75 potential donors identified for 38 transplant candidates, only 10 (13,3%) successfully met donation criteria (29). They concluded that current donor criteria markedly limit the application of living related liver transplantation. Their data are in sharp contrast with ours (whereas our selection policy is equally stringent).

The Kyoto group screened 135 potential donors for 120 potential pediatric recipients ; only 11,1% were rejected due to functional abnormalities (30).

Maximizing safety for the donor implies to limit the extent of liver resection to the left lateral segment or to the left lobe. This approach which was used exclusively until recently limits the applicability of the procedure. Indeed, the recipient needs to receive a graft of sufficient size to cover the metabolic needs from the day of the transplantation ; both extralarge and extrasmall transplants should be avoided to prevent failure (31). The use of a reinforced silastic prosthesis for closure of the abdominal wall in order to temporarily increase the capacity of the abdomen has eliminated the risk related to extralarge transplants as shown by our experience, including 16 LRLT (21).

The real problem is the transplant smaller than 40% of the standard liver volume (32) or with a ratio of graft weight to recipient body weight less than 1% (33). These prerequisites can not be fullfilled using the left lateral segment or even the full left lobe of an adult donor of small size for transplantation into recipients

of large size, like teenagers or for living donation between adult donors and recipients. In order to cope with this problem, a few groups worldwide have started during the recent years to procure the right lobe of the donor (34,35) ; in spite of its magnitude, this approach seems to be safe for the donor if the surgeon has appropriate expertise and follows very strict guidelines. Currently, our group is working up a protocol of living donation between adults, with procurement of the right lobe.

In the early experience with LRLT, the weak point was a high risk of arterial thrombosis due to the small size of the left hepatic artery (with sometimes a multiple arterial supply). The Chicago group circumvented the difficulty of arterial reconstruction by interposition of a saphenous vein allograft from the same donor, anastomosed to the infrarenal aorta of the recipient ; they reported an unacceptable high incidence (of 20% in their first 20 cases) (36). The Kyoto group recommended arterial reconstruction under operative microscope by a team of two surgeons specifically trained in microsurgery who step in the procedure for this part of the transplantation ; they reported a very low rate of arterial thrombosis (of 2,1% in their first 240 cases) (37). From the begining of our program, we opted for end to end arterial reconstruction with a semi-microvascular technique and magnifying glasses (× 6) that we are routinely using since many years for the vascular and biliary reconstructions of every transplant (38) ; with this approach, our rate of arterial thrombosis in LRLT has been kept to a very low rate of 1,6%, similar to the results reported by the Kyoto group with the operative microscope.

The high incidence of anastomotic biliary stricture in our experience is a serious concern although prompt recognition and surgical correction has limited the impact on graft and patient survival. The Kyoto group reported a 12,5% incidence of bile leaks (9,1%) and biliary stricture (3,4%) (39). Their lower incidence is possibly related to a lower level of recognition of biliary strictures because a large proportion of their patients are not followed in their own center on the long term (personal communication) whereas our team is following all recipients on the long term with a high level of clinical suspicion and a repeated search for biliary problems by a very experienced team of pediatric radiologists who have accumulated an exceptional expertise over our 15 year program of pediatric transplantation. Such a high incidence of anastomotic biliary strictures has also been observed in our own experience with left split grafts which are prepared using the same technique as for procurement of a left LRLT. The common denominator might be ischaemia of the terminal segment of the left bile duct caused by amputation of the filling of the peribiliary arterial network from the gastroduodenal artery and from the right hepatic artery with links between arterial supplies of the right and left livers through segment IV and the caudate lobe (40).

Conclusion

Clear ethical guidelines in the frame of a protocol approved by the Institution Ethics Committee should be followed in living related liver transplantation. Safety for the donor should be maximized ; extensive surgical expertise with all types of liver resection and transplants including split grafts is a prerequisite. Results regarding patient and graft survival are superior to those obtained with cadaveric transplants. Implementation of LRLT in expert teams is a valid way to obviate the shortage of cadaveric transplants.

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