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Pediatric liver transplantation: personal experience with 117 children and technical variants (reduced size liver, segmental graft, split liver)

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Summary

The development of pediatric liver transplantation (OLT) is considerably hampered by the dire shortage of donors of appropriate size. Two thirds of the children referred to our center are younger than 3 years. Under these circumstances, ethical pressure to find valid surgical alternatives when a size metched donor can not been found became increasingly higher. Three such techniques have been deseribed: the reduced size liver, the segmental or partial liver and the split liver.

Key words: Liver transplantation, the reduced size liver

Introduction

For children with end-stage liver disease, liver transplantation is the only therapy that provides the possibility of long term survival with a life of high quality. Indeed most of the successfully transplanted children enjoy a full physical and psycho-social rehabilitation [1].

Indications for transplantation

Cholestatic diseases account for 78.6 % of the transplanted children in our experience as well as in the Pittsburgh experience. The most frequent indication is biliary atresia after failure of the Kasai procedure which can be expected in two-thids of the patients operated in the Western world (one-third below 3 years, one-third between 3 and 14 years). Despite the progress obtained in liver transplantation, we consider that porto-enterostomy should be performed in every case below 3 months since it may significantly prolong the survival of the child even if long term cure is not provided by restoration of bile flow. Other cholestatic diseases leading less frequently to liver failure and transplantation include ductular paucity and sclerosing cholangitis.

Metabolic diseases are the next large category including Byler disease, Wilson disease, alpha1antitrypsin deficiency, tyrosinemia, Crigler-Najjar syndrome, glycogen storage disease, oxalosis, and even hemophilia. They account for 15.3 % in our experience. Various posthepatic cirrhoses including neonatal hepatitis, fulminant hepatitis and malignancies confined to the liver are less common indications in children than in adults.

In general, transplantation becomes the therapy of choice when survival longer than 2 years appears to be highly unlikely. The potential candidate should be refeerred to a center experienced in pediatric transplantation before the terminal stage since the best results are provided when the liver transplantation is performed electively.

In case of bleeding from oesophageal varices, palliative therapy like porto-caval shunt that may jeopardize the patient's suitability for transplantation should be ideally replaced by sclerotherapy.

The operative procedure

A-The donor operation.

Due to the sensitivity of the liver to warm ischemia, livers should be harvested only from brain dead, heart beating donors. The procedure used for procurement of multiple organs is well standardized [2]. A new preservation solution recently developed at the University of Wisconsin [3] allows preservation of the human liver up to 20 to 24 hours. In most centers, a satisfactory size match between donor and recipient is required with respective weights within 20 % of one another.

Due to the dire shortage of small pediatric donors, surgeons have been looking for safe technical variants. Transplantation of a reduced size liver harvested from a bigger donor, up to a weight ratio of 300 to 400 %, is such an alternative which we have used in over 50 cases with results of equal quality as after transplantation of a full size graft [4]. Other possibilities presently on the move are the segmental liver [5,6] allowing transplantation into a small child of a segment of an adult donor up to a weight ratio of 700 to 800 % and the split liver technique [7] with splitting of a single donor liver into two viable grafts fit for use in two different recipients. Three techniques have been described.

1) Reduced size livers.

From 1984 to 1988, 141 OLT were performed in 117 children under 15 years. Sixty % were less than 3 years (most under 12 kilos), 20 % were between 3 and 6 years and 20 % between 6 and 14 years. The indications were cholestatic diseases in 93 (biliary atresia. 86), metabolic diseases in 18 and miscellaneous in 6.

Of the 141 grafts, 54 were reduced size livers (38 %); they were evenly distributed between the age categories 36 % of the grafted performed in children less than 3 years, 42 % between 3 and 6 years and 40 % between 6 and 14 years. They represented 32 % and 62 % of the elective and urgent cases, 31 % and 50 % of the first grafts and of the retransplantations respectively. Fifty % of the grafts performed in 1986 and 1988 were reduced size livers. The mean weight ratio between donor and recipient was 3.5 (range 1,5-7,7). It was more than 4 in 11 occasions.

The graft loss rate was similar for reduced size livers and whole livers (22 % vs 20 %), the incidence of hepatic artery thrombosis being significantly lower for the reduced livers (7 % vs 17 %).

The one year patient survival rate was 78.3 %, 83.7 % and 76 % for the entire series, the whole livers and the reduced size livers respectively. For the elective cases, it was 85.6 %, 86.9 % and 83 % and for the urgent cases, 52.3 %, 62.5 % and 47 % respectively. The one year graft survival survival rate was 64.6 %, 70.7 % and 58.5 % for the entire series, the whole livers and the reduced size livers respectively. For the elective cases, it was 78.3%, 80.8 % and 73.3 %, for the urgent cases 37 %, 40 % and 34.5 %, for the first grafts 70.9 %, 75.5 % and 63.3 % and for the secondary grafts 42.8 %, 46 % and 36.8 % respectively. For the patients reaching the p.o. 6 months mark, 83 % and 80 % of the patients grafted with a whole liver (n=49), or a reduced liver (n=25) had normal (63 vs 76 %) or slightly abnormal liver tests (20 vs 4 %) respectively. None of the mentioned differences is statistically significant. We conclude that the transplantation of a reduced size liver is a safe and reliable technique which can be recommended even for the elective cases.

2) Segmental (partial) grafts

This technique allows to more easily cope with a weight ratio between donors and recipients in excess of 4. The largest experience has been gained by the Hannover group and the Drisbane group. Their results are matching those achieved with the reduced size livers.

3) The split liver

With this technique, the liver parenchyma of the donor liver is divided into two parts with partition of the liver pedicle to obtain two viable grafts fit for use. Within Curotransplant, the first

case was performed in Hannover followed by Paris, Chicago and Brussels. We personnally have used this technique in two occasions. In the first case, the liver of a 90 kgs donor was divided into a right part orthotopically transplanted in a 55 years old, 75 kgs recipient who was in hepatic coma, secondary to a non A non B cirrhosis (chronic renal failure due to chronic rejection of a kidney grafted 19 years earlier) and into a left part transplanted a a segmental liver in a 4 years old, 12 kgs child in subacute liver failure secondary to tyrosinemia. The adult recipient of the right liver died 6 days post-tx from infection and cardiac failure with technically successful liver and kidney grafts. The pediatric recipients of the segmental left liver is alive 3 months post-Tx with a normal liver function.

In the second case, the liver of a 10 years old, 30 kgs donor was splitted into a right part orthotopically transplanted into a 4 years, 16 kgs child who was suffering from severe bleeding due to portal hypertension secondary to biliary atresia (he had 2 weeks earlier undergone a small bowel resection for a bleeding angioma (?) and into a left part transplanted as a segmental graft in a 0 years, 10 kgs child (Alagille syndrome) who was on the waiting list since more than one year. The pediatric reciplent of the right liver died one day post-Tx from uncontrollable bleeding due to freed adhesions with a technically successful liver graft. The other child who received the left liver is alive 2 months post-Tx with a normal liver function.

B- The recipient operation

The technique of choice, used worldwide, is the orthotopic transplantation of the graft as described by T.E. Starzl. Removal of the diseased liver can be a formidable task in multioperated children with dense adhesions and severe portal hypertension. Decompression of the inferior vena caval system and of the portal tract during the anhepatic phase by means of an extracorporeal veno-venous bypass is not required in children.

The usual sequence of anastomoses of the new liver is first the upper (suprahepatic) vena caval anastomosis first, followed by the lower (infrahepatic) vena caval anastomosis and the end to end anastomosis of the portal vein; all three venous clamps are then released allowing portal reperfusion of the graft before performing the arterial anastomosis which requires a great care to minimize the risk of later thrombosis [8]. Biliary reconstruction is performed in most children using a Roux-en-Y choledoco-enterostomy over a small plastic stent. The whole operative procedure should be conducted with meticulous care to minimize the blood loss; a previous training with large animals in the experimental laboratory is extremely helpful for the liver transplant surgeon.

C- Post-operative care and follow-up

If the new liver is providing satisfactory function, the postoperative course can be simple from the surgical viewpoint. However most of the pediaric patients experience problems like arterial hypertension and one or more complications among which thrombosis of the hepatic artery is one of the most dreadful usually requiring retransplantation. Cooperation with an excellent unit of paediatric intensive care is essential.

Homotransplantation of the human liver requires an adequate immunosuppressive regimen to prevent rejection; much progress has been achieved since the introduction of Cyclosporine which is used in combination with Azathioprine and low-doses steroids. In spite of that, one or more episodes of acute rejection will be experienced by most patients, requiring for control either high doses steroids and/or monoclonal or polyclonal antibodies. Careful follow-up is mandatory to obtain normal liver function and to avoid chronic rejection which is less than 5 % in our experience but reaches 15 to 20 % in some centers.

Overall results

As an indication of what can nowadays be achieved in the field, we will summarize our own experience including 141 transplantations performed in 117 children below 15 years of age between March 1984 and December 1988. The indi-

cations for liver replacement were cholestatic diseases in 92 (biliary atresia: 86), metabolic diseases in 18 and miscellaneous in 7. The age of the recipients was between 0 and 3 years in 73 cases (ten below one year), betwen 3 and 6 years in 21 and between 6 and 15 years in 23.

Of the 141 grafts, 83 were full size livers (59 %) while 58 (41 %) were technical variants including a reduced liver in 54, a segmental graft in one and a split liver in 3.

The one year survival rate is 77 % for the entire group, 83 % for the elective patients (n=94) and 52 % for the urgent patients (n=23). Of 74 patients bearing functional grafts 6 months post-Tx, 67 % had completely normal liver tests and 14 % had slightly abnormal liver tests (SGPT and gamma-GT less than twice the normal values; normal bilirubin).

Most centers performind ten or more pediatric liver transplants annually are reporting one year survival probability of 60 % or more [9]. The majority of deaths in all series occur within the first 2 to 3 months after transplantation. Thereafter, the probability of survival remains rather constant in most series. Most of the surviving children presents a normal growth and development [10].

References

1. Zitelli BJ, Gartner JC, Malack JJ, et el: Pediatric liver transplantation: patient evaluation and selection, infectious complications, and life-style after transplantation. Transplant Proc 19:2420-2423, 1987.
2. Starzl TE, Hakala T, Shaw BW, JR et al: A flexible procedure for multiple cadaveric organ procurement. Surg Gynecol Obstet 158:223-230, 1984.
3. Kalayoğlu M, Sollinger HW, Stratta RJ, et al: Extended preservation of the liver for clinical transplantation. Lancet, 1:617-619, 1988.
4. Otte JB, de Ville D Goyet J, Sokal E, et al: Size reduction of the donor liver is a safe way to alleviate the shortage of size matched organs in pediatric liver transplantation. Submitted to Annals of Surgery.
5. Ringe B, Pichlmayr R, Burdelski M: A new technique of hepatic vein reconstruction in partial liver transplantation. Transplant International, 1:1, 30-35, 1988.
6. Strong R, Ong TH, Pillay P, et al: A new method of segmental orthotopic liver transplantation in children. Surgery, 104:104-107, 1988.
7. Otte JB, De Ville D Goyet J, A.berti D, et al: The concept and the technique of the split liver in clinical transplantation. Submitted to Surgery.
8. Tan KC, Yandza T, ed Hemptinne B, et al: Hepatic artery thrombosis in pediatric liver transplantation. J Pediatr Surg, 23:927-930, 1988.
9. The first European Symposium on Liver Transplantation in Children. Brussels, October 1986. Transplant Prof, 19:3227-3530, 1987.
10. Urbach AH, Garinerk JC, Jr, Malatack JJ, et al: Linear growth following pediatric liver transplantation. Am J Dis Child, 141:547-549, 1987.