

Case Report

Postoperative Management of Living Donor Liver Transplantation for Extrahepatic Biliary Atresia with Intrapulmonary Shunting: Report of A Case

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A six-year-old girl with biliary atresia underwent a living donor liver transplantation because of deteriorating intrapulmonary shunting related to portal hypertension. Following transplantation, the patient's oxygenation improved after the tenth postoperative day and returned to normal within thirty days. The important points of early post-transplantation management for intrapulmonary shunting are as follows: 1) coping with large volume of sputum and thus, if necessary, a prompt tracheotomy should be performed; 2) when dealing with persistent hypoxemia, it is essential to maintain the preoperative oxygenation levels and avoid any outflow disturbance of the graft liver; and 3) the prevention of the fatal vascular thrombosis. Phlebotomy to correct the presence of underlying polycythemia is also required.

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Introduction

Over the past decade in Japan, living donor liver transplantation (LDLT) has become established as the only viable treatment for end-stage liver diseases. By December 2002, a total of 2,226 of LDLT had been performed in Japan with satisfactory results.¹ The greater part of pediatric or adolescent LDLT candidates are extrahepatic biliary atresia and the major indications for LDLT include liver failure, relapsing cholangitis and gastrointestinal bleeding. It has recently been documented that intrapulmonary shunting related to portal hypertension may also improve after a successful liver transplantation (LT).^{2,3} However, even in Japan, the number of patients of LDLT for intrapulmonary shunting is limited and the key factors in effective postoperative management have yet to be fully elucidated. In order to help clarify this situation we herein report our experience in the postoperative management of LDLT for intrapulmonary shunting.

Case Report

A six-year-old girl underwent a hepatic porto-jejunostomy (the so-called Kasai procedure)⁴ after a diagnosis of extrahepatic biliary atresia on the 91st day after her birth. However, her postoperative liver function was almost within the normal range, her pulmonary function progressively worsened since five years of age. At 6 years of age, her partial pressure of arterial oxygen (PaO₂) became 52.1 Torr with the patient breathing room air. Digital clubbing and cyanosis were evident. She had complained of coughing and sputum in spite of an unremarkable chest roentgenogram. A ^{99m}Tc macroaggregated albumin (^{99m}Tc-MAA) lung scan showed an exacerbation in the intrapulmonary right to left shunting estimated to be 26% on January 7, 1997 and 32% on June 25, 1997.

At admission, her blood examination revealed a white blood cell count of 1.9×10³/L; a red blood cell count of 5.07×10⁶/L; a hemoglobin of 13.2 g/dL; a hematocrit of 38.6 %; a platelet count of 28×10³/L; total bilirubin of 1.9 mg/dL; direct bilirubin of 0.6 mg/dL;

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aspartate aminotransferase 30 IU/L; alanine aminotransferase 17 IU/L; hepaplastin test 47%; prothrombin time 54%; and anti-thrombin III 68%. The sequential blood gas studies for about two years before undergoing LDLT are summarized in Figure 1. She also had pulmonary shunt-associated orthodeoxia^{2,5} on her arterial blood gas analysis. She was considered to be a candidate for LT because of deteriorating intrapulmonary shunting related to portal hypertension.

On August 4, 1997, she underwent LDLT electively at Nagasaki University Hospital. The donor was her mother and the left lateral segment was used as a graft. The estimated ratio of graft weight to recipient weight was 1.6%, which was sufficient for both subsequent graft function and survival.⁶ The blood type between the recipient and donor was compatible. The operation time was 12 hr 42 min, and cold ischemic time was 2 hr 59 min. Both FK506 and steroids were used as postoperative immunosuppressants and also heparin and prostaglandin E1 were administered intravenously to prevent the vascular thrombosis. On the second postoperative day (POD), peritoneal bleeding required a re-laparotomy. In addition, on POD 7, a reconstruction of the hepatic artery was performed due to a ruptured pseudoaneurysm of the proper hepatic artery. There was no evidence of acute cellular rejection during her postoperative course.

The most serious problem in the postoperative cardiopulmonary

management was the treatment of a large volume of sputum. Because of the intractable volume of sputum, a tracheotomy was performed simultaneously with the POD 7 operation. Since then, the treatment of sputum was easily managed and no severe pulmonary complications occurred. On the other hand, for her underlying hypoxemia, the aim in the management of pulmonary function was to maintain the preoperative levels in the hemoglobin saturation determined by finger oximetry (SaO₂) and PaO₂. Positive end expiratory pressure (PEEP) was kept as low as possible to minimize the venous pressure in the suprahepatic inferior vena cava. We also maintained the hematocrit at about 30% and, if necessary, phlebotomy was performed to prevent the fatal vascular thrombosis.

The changes in the postoperative pulmonary function are summarized in Figure 2. Neither the SaO₂ nor PaO₂ reached to satisfactory levels in spite of a high level oxygen supply until POD 10. Thereafter, however, her oxygenation showed an immediate improvement and successfully recovered to normal levels by POD 30. The volume of the sputum correlated inversely with her oxygenation. A follow-up ^{99m}Tc-MAA scan on POD37 showed a complete resolution of the estimated shunt. The patient is doing well at six years and six months after LDLT at this writing.

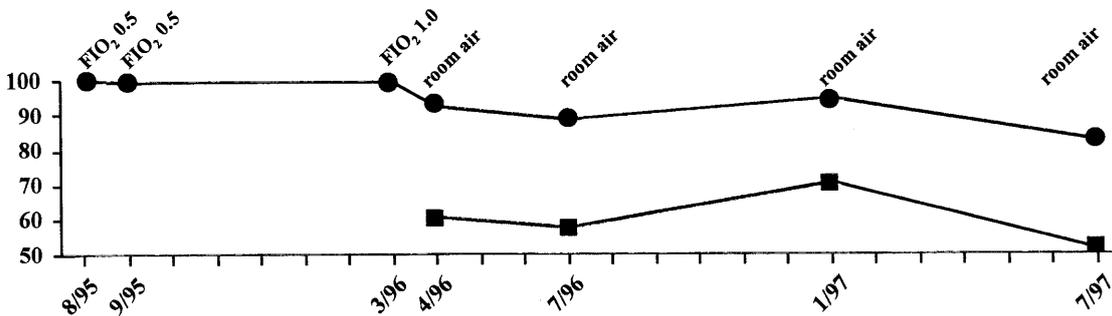


Figure 1. Diagram showing the progressive deterioration in oxygenation for two years before liver transplantation. Closed circle shows SaO₂ (%) and closed square shows PaO₂ (Torr).

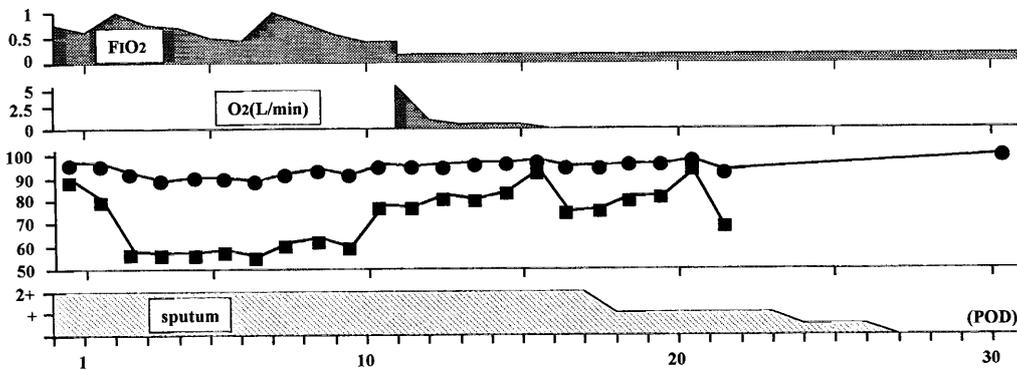


Figure 2. Diagram showing the early changes in pulmonary function after liver transplantation. Closed circle shows SaO₂ (%) and closed square shows PaO₂ (Torr).

Discussion

Hypoxemia and pulmonary hypertension associated with portal hypertension is classified as hepatopulmonary syndrome, and has been reported in the literature since 1930's.^{5,7} Although hepatopulmonary syndrome is considered to be caused by intrapulmonary shunting, it remains controversial as to why intrapulmonary shunting is related to portal hypertension.^{8,9,10} The symptoms and signs of intrapulmonary shunting include exertional dyspnea, cyanosis, and digital clubbing. Orthodeoxia or contrast echocardiography is useful in the diagnosis but a ^{99m}Tc-MAA lung scan is required to estimate the shunt ratio.^{11,12} Physiologically, persistent hypoxemia associated with intrapulmonary right to left shunting causes reactive polycythemia in vivo. Long standing hypoxemia also leads to a refractory state with irreversible pulmonary hypertension and is often easily accompanied by such fatal complications as infection and thrombosis.^{13,14}

Recent reports showed successful results with a recovery of intrapulmonary shunting related to portal hypertension after LT.^{2,15,16} Krowka et al.² reported that patients who showed a preoperative PaO₂ value of higher than 50 Torr successfully recovered after LT. On the other hand, in patients with a pretransplantation PaO₂ lower than 50 Torr or PaO₂ with 100% oxygen breathing lower than 400 Torr, the mortality was significantly more frequent. In the latter group of patients, the shunting tended to already be irreversible and fatal complications also easily occurred.

In Japan, the cumulative 5 year survival rate of LDLTs is 76.7%.¹ About 50% of all patients were pediatric patients and the majority of them had extrahepatic biliary atresia. The number of candidates who have undergone LDLT for indications of intrapulmonary shunting related to portal hypertension is limited.¹⁶ We thus herein describe the care and postoperative management of a LDLT for intrapulmonary shunting based on the present experience.

First of all, patients with intrapulmonary shunting tend to have severe cough and sputum symptoms. The treatment of these symptoms is quite important in the critical postoperative state. Especially, in the post-LDLT state medicated with immunosuppressants, pulmonary complications such as severe pneumonia may be fatal and effective prophylaxis is essential. In addition to the general respiratory management, serial cultures of the sputum and the administration of effective antibiotics are also required. Moreover, when necessary, surgeons should not hesitate to promptly perform a tracheotomy.

Secondly, in the post-LDLT state, it is important to effectively manage persistent hypoxemia. In the postoperative state for our patient, adequate circulatory kinetics was obtained by maintaining the preoperative SaO₂ and PaO₂ levels. Unlike whole liver transplantation, LDLT usually needs anastomosis of the hepatic veins between the transplanted graft and recipient. As a result, to carelessly load PEEP is considered dangerous. Excessive PEEP may elevate the intrathoracic pressure and cause an outflow disturbance of the hepatic vein of the graft liver, thus resulting in fatal graft failure. In our patient, we set the limit of PEEP within 3cmH₂O, which showed no signs of any outflow disturbance. Another important point was

graft oxygenation after LT. Can the graft liver survive at the donor's normal PaO₂ level if exposed to the recipient's hypoxemia? With respect to this question, Kitai et al.¹⁷ monitored the post-LDLT graft liver SaO₂ in their LDLT patients for intrapulmonary shunting and concluded that the graft liver could tolerate hypoxemia and thus maintain a sufficient hepatic function.

The third point is the use of appropriate countermeasures to treat polycythemia. One of the most serious complications after LT is vascular thrombosis. Patients with intrapulmonary shunting tend to demonstrate polycythemia and should thus be considered a high risk group for vascular thrombosis.¹⁶ Uemoto et al.¹⁸ analyzed their LDLT patients with intrapulmonary shunting and concluded that the patients with a shunt ratio of over 40% are prone to develop two major complications, namely infection and thrombosis, and also show poor prognosis. The hematocrit level is of critical importance in comparing the two alternatives. Elevated hematocrit levels increase the viscosity of the blood and promote the risk of thrombosis, while reduced levels exacerbate hypoxemia. In our patient, we maintained the hematocrit at about 30% and, if necessary, phlebotomy was also performed.

It remains controversial as to when LT should be performed in patients with intrapulmonary shunting related to portal hypertension. In Japan, many of these candidates are elderly or school children with extrahepatic biliary atresia and thus are significantly older than non-hypoxic candidates and also have clinically stable hepatic dysfunction.¹⁸ Our patient had no clinical signs of exertional dyspnea even though she had a 32% shunt ratio. The sequential exacerbation in her pulmonary function played a critical role in finally selecting LDLT. In conclusion, we emphasize that a deteriorating shunt ratio over 25% may therefore be the indicative criterion for LT, although a prospective controlled study is still called for to clarify this point.

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