

High incidence of postoperative pulmonary complications after orthotopic liver transplantation in children

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Abstract: Postoperative pulmonary complications were investigated in a total of 41 pediatric recipients who underwent orthotopic liver transplantation (OLT) between January, 1990 and March, 1992 at the Royal Children's Hospital, Brisbane. Atelectasis was seen in 40 cases (98%) of the 41 recipients, and occurred in the left lower lobe in 28 cases (68%), and in the right upper lobe in 25 cases (61%). Radiographic pulmonary edema occurred on 23 occasions in 18 recipients (45%). Pulmonary edema was observed just after operation in 9 cases, and in the later stage from the 3rd to 25th postoperative day in 14 cases. Five recipients experienced two episodes of pulmonary edema during their ICU stay. The duration of mechanical ventilatory support was significantly longer in the patients with pulmonary edema than in those without (9.6 ± 3.8 vs 3.9 ± 2.2 days, $P < 0.01$). Pleural effusions were observed in 21 cases (52%), of which 18 had right-sided effusion and 3 had bilateral effusions. Pneumothorax occurred in three cases. Pyothorax, hemothorax, bronchial asthma, and subglottic granulation occurred in one case each. The present study demonstrated that postoperative pulmonary complications are frequently observed in pediatric recipients undergoing OLT.

Key words: Pulmonary complication, Pediatric orthotopic liver transplantation

Introduction

Orthotopic liver transplantation is currently an accepted therapeutic option for treatment of pediatric patients with biliary atresia and for hepatic replacement in certain inherited metabolic disorders. However, these patients have a great risk of developing pulmonary complications. Many patients undergoing liver

transplantation have preexisting alveolar-to-arterial oxygen gradient abnormalities including intrapulmonary arteriovenous shunting and atelectasis resulting from massive ascites [1]. In addition, a postoperative reduction in vital capacity and functional residual capacity may be produced by the elevated intraabdominal pressure secondary to the large grafted liver and edematous bowel [2], which also increases the risk of pulmonary complications.

The purpose of this study was to determine the incidence of pulmonary complications in pediatric patients undergoing orthotopic liver transplantation (OLT), and to compare the duration of mechanical ventilatory support in two groups with and without pulmonary edema.

Materials and methods

Between January, 1990 and March, 1992, a total of 41 OLTs were performed on 36 children at the Royal Children's Hospital, Brisbane. Five of the children received a second OLT following failure of the first graft. Twenty were girls and 16 were boys, with a mean age of 2 years and 7 months (range, 7 months to 13 years). The mean body weight was 11.9 kg (range, 6.8 to 35.0 kg). The underlying disease was extra-hepatic biliary atresia in 32 cases, α_1 -antitrypsin deficiency in 2 cases, Alagille's syndrome in 1 case, and Crigler-Najjar syndrome in 1 case. Of these patients, 30 received reduced-size adult liver transplants from cadavers, 2 received segmental liver transplants from living related donors [3], and the remaining 9 received whole liver transplants from cadavers. The mean durations of operation and anesthesia were about 10.5 and 13.5 h, respectively.

On arrival at ICU, invasive pressure monitoring with an arterial line and central venous line was continued until the patient became hemodynamically stable. All patients received $3 \mu\text{kg}^{-1}\cdot\text{min}^{-1}$ fentanyl and $10\text{--}50 \mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ midazolam for 48–72 h. Low dose

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dopamine ($1-3\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) was continued to promote adequate urine output. All patients were ventilated with the tidal volume and respiratory rate adjusted to maintain arterial carbon dioxide tension at 35–40 mmHg. Positive end-expiratory pressure (PEEP) of 5 cmH₂O was used routinely to prevent atelectasis.

Pulmonary complications following liver transplantation were detected by the findings of chest radiography which was performed every day during the stay in ICU. All of radiographical findings were examined by an experienced radiologist.

Atelectasis was defined as a decrease in the volume of lobes and/or segments. Pleural effusion and pneumothorax were defined as the presence of fluid and gas retention in the pleural cavity, respectively. Hemothorax and pyothorax were diagnosed by thoracic puncture, and pneumonia was diagnosed by laboratory and roentgenographic features. Pulmonary edema was defined as the presence of the following findings under mechanical ventilation: bilateral diffuse infiltrates on chest radiography and $\text{Pao}_2 < 70$ mmHg with $\text{FiO}_2 0.6$ and PEEP more than 8 cmH₂O. Subglottic granulation was diagnosed by means of bronchoscopy.

Sepsis was diagnosed in the presence of the following findings: clinical evidence of infection; rectal temperature $\geq 38.5^\circ\text{C}$; white blood cell count $\geq 15\,000/\text{ml}$ with many immature forms.

The durations of mechanical ventilatory support were compared between two groups with and without pulmonary edema, using unpaired Student's *t*-test. *P* values less than 0.01 were considered significant.



Fig. 1. Incidence of atelectasis in each lobe during the stay in ICU after pediatric orthotopic liver transplantation (OLT) ($n = 41$)

Results

Table 1 shows the incidence of pulmonary complications after OLT in children.

Out of 41 recipients, a total of 40 (98%) had atelectasis. Figure 1 shows the incidence of atelectasis in each lobe. The left lower lobe was the most frequent site (70%), followed by the right upper lobe (61%). Twenty-five cases (61%) had atelectasis in 2–4 lobes simultaneously or consecutively.

A total of 21 patients (52%) had pleural effusion. Pleural effusion occurred unilaterally on the right side in 18 recipients, and bilaterally in 3. Pleural drainage was performed in eight cases (19%) during the stay in ICU. Out of 21 patients with pleural effusion, pulmonary edema coexisted in 10 (48%).

Table 1. Incidence of pulmonary complications in 41 pediatric cases of orthotopic liver transplantation

Complication	Number of patients	Percentage
Atelectasis	40	97.6
Pleural effusion	21	51.2
Pulmonary edema	19	46.3
Pneumothorax	3	7.3
Hemothorax	1	2.4
Pyothorax	1	2.4
Bronchial asthma	1	2.4
Subglottic granulation	1	2.4
Pneumonia	1	2.4

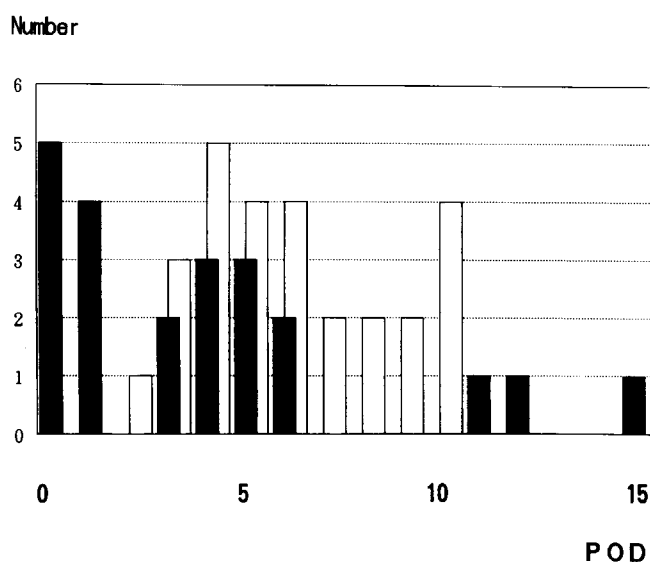


Fig. 2. Incidence of pulmonary edema (closed bars) and sepsis (open bars) in the postoperative period after pediatric OLT. Sepsis occurred from the 2nd to 10th postoperative day and was often associated with pulmonary edema

Pulmonary edema occurred on 23 occasions in 18 recipients (45%). Five recipients experienced it twice while in ICU. Figure 2 shows the incidence of postoperative pulmonary edema. Pulmonary edema was observed just after operation in 9 cases, and in the later stage, from the 3rd to 15th postoperative day, in 14 cases.

The duration of mechanical ventilatory support was 7.8 ± 8.5 days (range, 1–51 days). Then, it was significantly longer in the patients with pulmonary edema than in those without (9.6 ± 3.8 vs 3.9 ± 2.2 days, $P < 0.01$).

Pneumothorax occurred in three cases. Hemothorax, pyothorax, bronchial asthma, subglottic granulation, and pneumonia each occurred in one case.

Out of 41 recipients, 37 survived and were discharged from ICU, and 4 died in ICU. The cause of death were sepsis in three cases and sudden intraabdominal hemorrhage in one case. Although a high incidence of pulmonary complications was observed in these patients, these complications were not directly related to the cause of death.

Discussion

Abnormalities of pulmonary function are common in patients following liver transplantation. The compliance of the lungs and chest wall may be decreased by postoperative ascites, pleural effusions, and pulmonary edema. In addition, hypoxemia may occur since most of the patients have ventilation-perfusion mismatching [4] and intrapulmonary arteriovenous shunting [2] due to liver cirrhosis.

Atelectasis is a particularly common problem postoperatively. Atelectasis was seen in all cases except one, and it occurred repeatedly during the patients' stay in ICU. The causes of atelectasis were not determined in each case, but it might be associated with decreased movement of the diaphragm, abdominal distension, pain, and tracheobronchial infections. Chest physiotherapy including a combination of therapeutic positioning, percussion to the chest wall over the affected area and vibration of the chest wall during expiration appeared to be effective for the treatment of atelectasis. Prolonged atelectasis should be avoided to prevent pneumonia, which may be catastrophic in immunosuppressed patients who have received transplants. In a total of 40 cases of atelectasis, pneumonia developed in only one patient. The cause of pneumonia in this case

was cytomegalovirus infection, and administration of gancyclovir was very effective.

Pleural effusions occurred frequently in these patients, and were usually right-sided. The cause of pleural effusion was not clear in every case, but it often appeared to be associated with fluid overload. Pleural effusion may also be attributed to trauma induced by inadvertent clamping of a small section of the right hemidiaphragm as the suprahepatic vena cava is clamped. Usually, diuretics are effective in decreasing the pleural effusion. Pleural drainage is indicated when respiratory distress is present. Although pleural drainage is technically very simple, the procedure should be undertaken with caution since numerous collateral vessels and coagulopathy may be present secondary to the preexisting liver disease [5].

Pulmonary edema occurs secondary to fluid overload [6] and sepsis. Pulmonary edema seen just after the operation was managed easily with diuretics and fluid restriction. On the other hand, pulmonary edema observed several days after operation was not easy to treat, and was often associated with sepsis (Fig. 2). To maintain P_{aO_2} greater than 70 mmHg despite an FiO_2 of 0.6, PEEP was maintained at levels above 8 cmH₂O in these cases. Of 36 patients, 3 died due to sepsis.

The present study demonstrated a high incidence of pulmonary complications in pediatric patients undergoing OLT. Although pulmonary complications are rarely directly related to the cause of death [7], they may affect the pathological condition of the patient and may necessitate longer mechanical ventilatory support.

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