residual tumor tissue. Subsequently, after reinsertion of the tracheal tube, a right anterolateral tracheotomy was performed between the second and the third rings of tracheal cartilage. The residual tumor was resected from inside the trachea with resection of a small part of the second ring of tracheal cartilage. The tracheotomy was primarily closed with separate sutures of polypropylene 4/0. The sutures were covered with a layer of fibrin glue. Postoperative course was uneventful, and the patient was discharged from the hospital on the 13th postoperative day. Her voice had not changed, and at control laryngoscopy after 3 months, the lumen of the trachea was free of tumor and the tracheal mucosa had completely healed. Periodic follow-up examinations with direct laryngoscopy were prescribed.

**Discussion**

The finding of ectopic thyroid tissue in the trachea has been reported previously. Two theories exist regarding this pathologic finding. One theory, that of fetal malformation, postulates that the developing thyroid is divided by the developing trachea and its cartilage rings. Another theory suggests an ingrowth of thyroid tissue into the tracheal lumen.1-4

The most common clinical feature is stridor due to upper airway obstruction, and it frequently is mistaken for asthma with only partial response to treatment.5,6 Diagnosis is made by endoscopic evaluation. Typical here is a smooth reddish-brown mass in a subglottic posterolateral position.7 Biopsy specimens should be obtained if possible. Ulceration, multiple nodules, and bleeding should alert the clinician to possible malignancy.

Thyroid isotope scans are not helpful because the thyroid gland obscures visualization of the intratracheal thyroid tissue.7,8 A CT scan gives important information on the extent of the tumor and the tracheal obstruction. Special attention should be given to malignant features and lymph node enlargement. Differential diagnosis includes other benign conditions like papilloma, enchondroma, osteoma, amyloid deposits, and malignant diseases like thyroid carcinoma invading the trachea, degeneration of the ectopic intratracheal thyroid tissue, or nonthyroid malignant neoplasms like chondrosarcoma, squamous cell carcinoma, or lymphoma.4

Treatment consists of surgical exploration and resection. Intraluminal treatment with the laser has one important disadvantage: a histopathologic examination for malignant degeneration is not possible. If possible, the tracheal mucosa should be left intact.4 We found that intraoperative controlled endoscopy was helpful in evaluating the completeness of the resection.

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**End-Stage Cystic Fibrosis**

**Improved Diabetes Control 2 Years After Successful Isolated Pancreatic Cell and Double-Lung Transplantation**

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Over a period of years, insulin-dependent diabetes and respiratory insufficiency developed in a 35-year-old patient with end-stage cystic fibrosis. After waiting more than 4 years while receiving maintenance treatment with continuous liquid O2 and nasal ventilation, the patient underwent double-lung and pancreatic islet cell transplantation. Subsequently, the patient has enjoyed a normal life with full employment and much better control of his diabetes. Pancreatic islet cell transplantation is a simple and innocuous technique easily added to the end of lung transplantation. These new pancreatic cells, although locally injected, are still secreting more than 2 years later as assessed by repeated C-peptide measurements. (CHEST 1997; 112:1655-87)

**Key words:** cystic fibrosis; diabetes; lung transplantation; pancreatic islet cell transplantation

**Abbreviations:** CF=cystic fibrosis; IDD=insulin-dependent diabetes

Insulin-dependent diabetes (IDD), which can be quite unstable, may develop in patients with end-stage cystic fibrosis (CF) who suffer from severe respiratory insufficiency.1 Lung transplantation represents the last opportunity for therapy2,3 and could be combined with pancreatic islet cell transplantation. However, patients with CF cannot simultaneously tolerate thoracic and abdominal surgery. Since pancreatic islet
cell transplantation without open surgery has been performed in patients with diabetes mellitus, such a procedure could be accomplished simultaneously with bilateral lung transplantation.

The case of a 35-year-old CF patient with very severe respiratory insufficiency and IDD is reported here. This patient was receiving maintenance treatment for more than 4 years with continuous O2 therapy and ventilatory support. Two years after simultaneous sequential bilateral single-lung transplantation and isolated pancreatic islet cell transplantation, he is free of further respiratory problems and his diabetes is much better controlled with fewer daily insulin requirements despite regular use of immunosuppressant drugs including prednisone.

**CASE REPORT**

The patient had CF since his birth in 1961 when he had a meconium ileus and positive sweat test. IDD was discovered when he was 20 years old. His daily insulin requirements were regularly more than 100 IU during the last 10 years. From 1983, sputum cultures grew Pseudomonas aeruginosa continually, and regular courses of antibiotics were administered while he was hospitalized. In 1988, he stopped working due to poor health. He showed chronic severe hypoxemia (pH, 7.41; PaO2, 53 mm Hg; PaCO2, 49 mm Hg; arterial oxygen saturation, 85% under ambient air and in best stabilized conditions) and received long-term O2 therapy with a concentrator (De Vilbiss; Dietzenbach, Germany). In January 1990, his name was added to a waiting list for heart-lung transplantation. An endovenous continuous catheter (Portacath; Pharmacia; Uppsala, Sweden) was inserted to allow home antibiotic therapy. Despite compliance with home long-term O2 therapy (mean daily duration, 22.2 h/d), the patient remained highly dyspneic; edema due to cor pulmonale developed. In June 1990, nasal ventilation (PLV-100; Lifecare; Boulder, Colo) was started for at least 4 h/d, and organized home support with nurses and respiratory therapists was initiated. In 1992, despite a long hospital stay with intensive care, including nutritional and antibiotic therapy, worsening hypoxemia and hypercapnia could not be controlled. Because home delivery of liquid O2 was unavailable, a connection was created directly from the hospital tank to fill a portable liquid O2 cylinder (Heimox-nobil S/T; Puritan Bennett Fangas; Luzern, Switzerland) to maintain the patient’s arterial oxygen saturation at more than 90% until transplantation. His diabetes was difficult to control despite a high dosage of insulin. During the last 6 months before transplantation, the patient recorded blood glucose levels three times daily (Accutrend; Boehringer Mannheim; Rotkreuz, Switzerland), along with the number of symptomatic hypoglycemic events, and the daily dose of insulin (Table 1).

On Feb 20, 1994, after 4 difficult years on the waiting list, a successful bilateral sequential single-lung transplantation was done. At the same time, purified islet cells from the same donor were injected percutaneously into the transverse colic vein (4,146 islets/kg body weight). During the first 10 days, antithymocyte globulin (Atgam; Upjohn; Kalamazoo, Mich) was administered. After an episode of intrathoracic bleeding and 2 instances of pneumothorax, the patient was discharged on a regimen of immunosuppressive therapy consisting of cyclosporine, azathioprine, and prednisone.

Since then, the patient has remained in good condition and has resumed his work as a bank employee. Fasting C-peptide levels, which were undetectable (<0.04 nmol/L) before pancreatic islet cell transplantation, have increased to within or above the normal range (normal values, 0.30 to 1.20 nmol/L). There has been considerable improvement in his lung function (Table 1) and a sustained decrease in the daily requirement of insulin. Moreover, blood glucose levels have been more stable after transplantation, and the patient has been totally free from hypoglycemic episodes.

**DISCUSSION**

This case is noteworthy for the following reasons. First, this is believed to be the first patient with CF who received simultaneous sequential bilateral single-lung and pancreatic islet cell transplantation. Transplantation of islets of Langerhans’ cells has been performed in type 1 or 2 diabetes combined with kidney or liver transplantation. More than 200 patients worldwide have received pancreatic islet cell transplantation with short-term improvement in insulin requirement due to the functioning islet graft as measured by circulating C-peptide levels. The patient’s name was on a waiting list for more than 4 years before a double-lung transplantation could be performed. To control his severe respiratory insufficiency, he needed not only home continuous liquid O2 therapy but also noninvasive nasal ventilation. He also received nutritional support and careful control of diabetes to keep him in good health for transplantation (55 kg/165 cm; body mass index, 19.9).

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### Table 1—Spirometry and Diabetic Parameters Before and 6 Months After Bilateral Sequential Single-Lung and Pancreatic Cell Transplantation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Before</th>
<th>After, 2 mo</th>
<th>After, 24 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1, L/s*</td>
<td>0.4 (11%)</td>
<td>3.1 (82%)</td>
<td>3.0 (79%)</td>
</tr>
<tr>
<td>FVC, L*</td>
<td>1.0 (21%)</td>
<td>3.4 (75%)</td>
<td>3.5 (77%)</td>
</tr>
<tr>
<td>Venous glucose, mmol/L†</td>
<td>6.1±2.8 (2.3-12.1)</td>
<td>9.0±1.2 (4.2-10.9)</td>
<td>5.8±0.9 (3.8-8.5)</td>
</tr>
<tr>
<td>Daily insulin, IU/d†</td>
<td>102±13</td>
<td>60±2</td>
<td>66±2</td>
</tr>
<tr>
<td>Fasting C-peptide, mmol/L</td>
<td>&lt;0.04</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Hypoglycemic events/wk‡</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hyperglycemic events/wk‡</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

*For FEV1 and FVC, values in parentheses represent percent of predicted values.

†Mean ± SD (range). Venous glucose levels measured three times daily over a period of 1 month.

‡Values represent mean number of symptomatic hypoglycemic events per week.

§Values are mean number of glucose values >10 mmol/L per week.
Second, a sustained improvement in the control of diabetes, as measured by diminished daily need of insulin, better clinical stability of blood glucose values, and total suppression of any hypoglycemic events after transplantation despite the use of prednisone, have been documented. At 2 months after transplantation, the patient received daily 500 mg of cyclosporine, 100 mg of azathioprine, and 20 mg of prednisone. After 24 months, this immunosuppressive treatment is unchanged apart from prednisone, which has been tapered to 10 mg a day. The suppression of the severe respiratory disease, with continual Pseudomonas infection, by double-lung transplantation certainly plays a role in better control of the diabetes.

However, whatever the reason for this improvement, the absence of any detectable C-peptide levels before transplantation and the return to normal levels thereafter definitely support the belief that some insulin is secreted by the transplanted exogenous pancreatic cells. This also explains, to some extent, the better control of the diabetes. Simultaneous pancreatic islet cell transplantation is not technically difficult when using the technique of intravenous embolization of islet cells into the liver of the patient receiving the transplanted lung. Further studies will show whether these patients benefit more than other diabetics from this additional transplantation and whether complications of diabetes in CF patients can be prevented by pancreatic islet cell transplantation.7-9

The quality of life of this patient was drastically changed. Two months after the intervention, he was able to resume working and was married 6 months later. He already shows long-lasting advantages from his pancreatic islet cell transplantation: blood glucose levels have become more stable over time as shown by the three times daily measured values and hypo- and hyperglycemic episodes have completely disappeared. Insulin requirements of about 60 IU/d will probably decrease over time with prednisone dose tapering. Thus, pancreatic islet cell transplantation for IDD merits consideration in patients with end-stage CF on whom lung transplantation will be performed.

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REFERENCES


Pulmonary Cholesterol Crystal Embolization*

Marc S. Sabatine, MD; David A. Oelberg, MD; Eugene J. Mark, MD; and David Kanarek, MD

Background: Cholesterol crystal embolization (CCE) has been documented to affect nearly every organ system. However, CCE involving the lung is distinctly uncommon and has been documented only in the setting of an aortocaval fistula.

Design: A case at the Massachusetts General Hospital and a MEDLINE search of English-language medical articles published between 1966 and 1997 provide the basis for this report.

Results: The precipitants of CCE include invasive vascular procedures, anticoagulant therapy, and thrombolysis. The most common symptoms include claudication of the calf, gastrointestinal bleeding, and weight loss. The most common signs include livedo reticularis, gangrene, and ulcers. Azotemia, proteinuria, normocytic anemia, and eosinophilia often are found. Herein is described the first pathologically confirmed case of CCE to the lung in the absence of an aortocaval fistula.

Conclusion: Pulmonary hemorrhage should now be included in the diverse list of presenting signs of CCE. Moreover, CCE should be considered in the differential diagnosis of pulmonary-renal syndromes.

(CHEST 1997; 112:1687-92)

Key words: atheroembolism; cholesterol; embolism; pulmonary hemorrhage; renal failure

Abbreviation: CCE=cholesterol crystal embolization

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