

Successful Weaning from Prolonged Mechanical Ventilation by Embolization of Aorta-pulmonary Collateral Arteries

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Transcatheter embolization (TCE) of the bronchial artery has been used to treat massive hemoptysis due to various causes^{1,2}. Multiple aorta-pulmonary collateral arteries (MAPCA's) are commonly found in patients with severe pulmonary stenosis³, and often present special problems, such as massive intracardiac return of blood during surgical correction⁴, postoperative heart failure secondary to pulmonary overcirculation⁵, and hemoptysis⁶.

We hereby report on a patient with tetralogy of Fallot, who was successfully weaned from prolonged mechanical ventilation following a total correction by a transcatheter embolization of the intercostal arteries suspected of MAPCA's.

Case Report

A 15-year-old girl was transferred to the ICU after total correction of a tetralogy of Fallot with pulmonary atresia.

She had experienced limited physical activity and cyanosis since she was a baby,

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and had been diagnosed as pseudotruncus arteriosus at one year of age. A left Blalock-Taussig anastomosis had been performed at one year of age, and a right anastomosis at five. A cardiac catheterization and an angiogram at 15 years of age revealed enlarged MAPCA's of the intercostal arteries which arose bilaterally from the descending aorta to the bilateral pulmonary arteries accompanied by an absence of confluence between the pulmonary arteries and the heart.

A total corrective operation was therefore performed. Since a remnant of the main pulmonary artery was observed, she was diagnosed as tetralogy of Fallot with pulmonary atresia. As many collateral vessels as possible were identified and subsequently obliterated in the process of performing a median sternotomy incision.

Even after two weeks postoperatively, she could not be weaned from mechanical ventilation because of severe heart failure and massive hemoptysis, which could not be controlled by conservative management. Echocardiography revealed a hyperdynamic state of the left ventricle. Chest radiography revealed an enlarged heart, and airway consolidation on the right upper and middle lung fields (fig. 1a). On bronchofiberscopy, an active hemorrhage from the right upper lobe bronchus was observed. Angiography revealed enlarged intercostal arteries from the

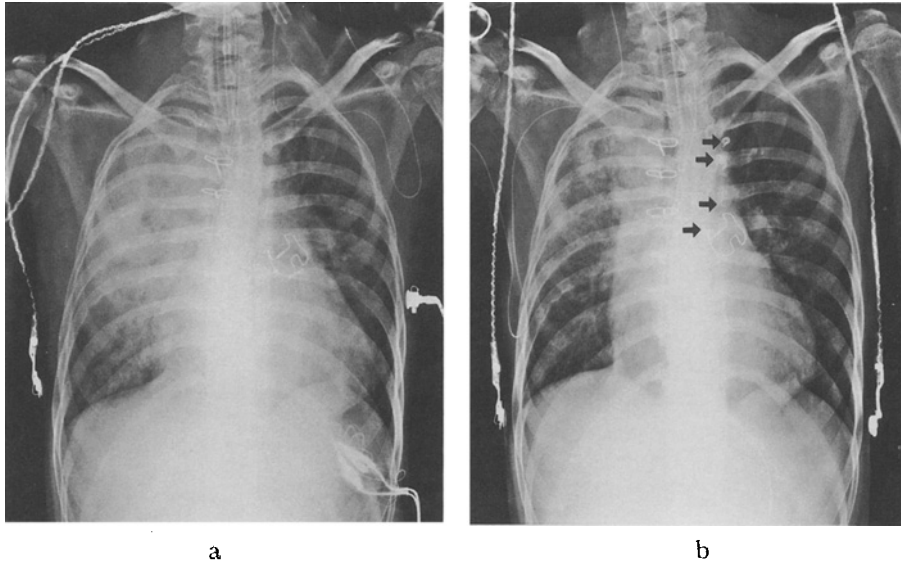


Fig. 1. a. Digital chest radiography before embolization. Airway consolidation in right upper and middle lung fields, and cardiomegaly are present.
 b. Digital chest radiography taken about three weeks after spring-coil embolization (arrows). Clearing of pulmonary infiltrates and reduction of heart size are present.



Fig. 2. Digital subtraction angiogram of right intercostal artery, demonstrating prominent hypervascularity, marked dilatation, and anastomosis with pulmonary arteries to right upper lobe.

descending aorta to the right pulmonary arteries (fig. 2), which were considered to be MAPCA's, and were probably the cause of both the hemoptysis and heart failure following pulmonary overcirculation. Therefore, the right five intercostal arteries were occluded by TCE with spring-coil devices on Day 18. As a result, the hemoptysis de-

creased within three days, a reduction of heart size and a clearing of pulmonary infiltrates on chest radiography were noted within three weeks (fig. 1b). After TCE, an increased respiratory rate and paradoxical motion of chest versus abdomen, and CO₂ retention were observed during the weaning attempts. An increased nutritional repletion regimen, using a glucose-fat mixture and respiratory muscle training were begun. The vital capacity increased gradually from 0.3 l to 1.0 l, and the weaning was completed by Day 48. She has not had any episodes of hemoptysis since the successful weaning.

Discussion

This is the first reported case that has been successfully weaned from prolonged mechanical ventilation by TCE of MAPCA's following a total correction of tetralogy of Fallot with pulmonary atresia. In the present case the causes of failure in the weaning from mechanical ventilation were thought to be heart failure, massive hemoptysis, and respiratory muscle fatigue.

As many collaterals as possible were ligated during the total corrective operation.

After the operation, however, congestive heart failure and severe hemoptysis were present, and were considered to have derived from the remaining MAPCA's. The site of a large left to right shunt and hemorrhage was localized by chest X-ray films and bronchoscopy. Therefore, the TCE of the intercostal arteries was performed with the successful interception of the MAPCA's.

Although the utility of TCE of the bronchial arteries in the management of massive or recurrent hemoptysis has been well documented^{1,2}, there are only a few reported cases with pulmonary atresia, that have TCE of MAPCA's. This was used to control the following; hemoptysis due to small MAPCA's⁷, postoperative congestive heart failure due to large MAPCA's⁸, and massive cardiac return of blood during cardiomy⁴. TCE is usually only a palliative and temporary maneuver, since the underlying disease of the lung remains, as suggested in the many previously published papers^{1,2}. New MAPCA's can and do occur, and are predisposed to recurrent bleeding. We consider, however, that TCE by itself can be a primary method of treatment for problems due to MAPCA's in patients in whom the underlying disorders, which lead to the development of MAPCA's, can be corrected, and who are poor surgical candidates.

It was still difficult for this patient to be weaned from the mechanical ventilation even after the TCE, because of respiratory muscle fatigue. The weaning was completed with respiratory muscle training and increased nutritional repletion. Chronic heart diseases are often associated with undernourishment⁹. Malnutrition recently has been shown to impair respiratory muscle structure and function¹⁰. In malnourished patients, we consider that a regimen of nutritional repletion and respiratory muscle training should be started as soon as possible after the operation, or even, if possible, started before surgery.

In summary, a 15-year-old girl with tetralogy of Fallot and pulmonary atresia underwent a total surgical correction. Weaning from mechanical ventilation was difficult due

to severe hemoptysis and heart failure. This condition was most likely precipitated by the enlarged intercostal arteries connecting to the pulmonary arteries. After transcatheter embolization of these arteries, the weaning was successfully completed.

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