Surgical Repair for Tracheo-Innominate Artery Fistula with a Muscle Flap

A 70-year-old woman was quickly diagnosed as having tracheo-innominate artery fistula by three-dimensional computed tomography. Immediate surgical exploration was performed to control the bleeding using a temporary shunt. After the damaged artery was excised, vascular reconstruction was performed to preserve the connection between the proximal and distal ends of the innominate artery with the interposition of a saphenous vein graft. A pedicled sternocleidomastoid muscle flap was successfully used for the tracheal reconstruction. (Jpn J Thorac Cardiovasc Surg 2003; 51: 630–633)

Key words: computed tomography, tracheo-innominate artery fistula, muscle flap

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Tracheo-innominate artery fistula (TIF) is an unusual but lethal complication of tracheostomy.[1,2] It occurs with a frequency of approximately 0.7% and is always fatal if not diagnosed and surgically repaired.[1] Mucosal damage by the tracheal cannula, pressure necrosis due to a high cuff pressure, or mucosal trauma from an improperly positioned cannula tip results in erosion through the tracheal wall into the vascular structures that lie in the pretracheal space.[2] The successful management of TIF basically depends on its early diagnosis, but this is usually difficult. TIF should be suspected in patients showing one of two clinical signs: sentinel hemoptysis or pulsation of the tracheostomy tube. No consistently useful diagnostic tools have been developed for tracheo-arterial fistula. Bronchoscopy is often inadequate for establishing the diagnosis, and there may not be sufficient time for angiographic studies. However, in this report, we describe a case of TIF in which the diagnosis was rapidly established by three-dimensional images obtained by multislice helical computed tomography (CT). We reconstructed the innominate artery using the interposition technique with a saphenous vein graft while maintaining cerebral blood flow with a temporary shunt.

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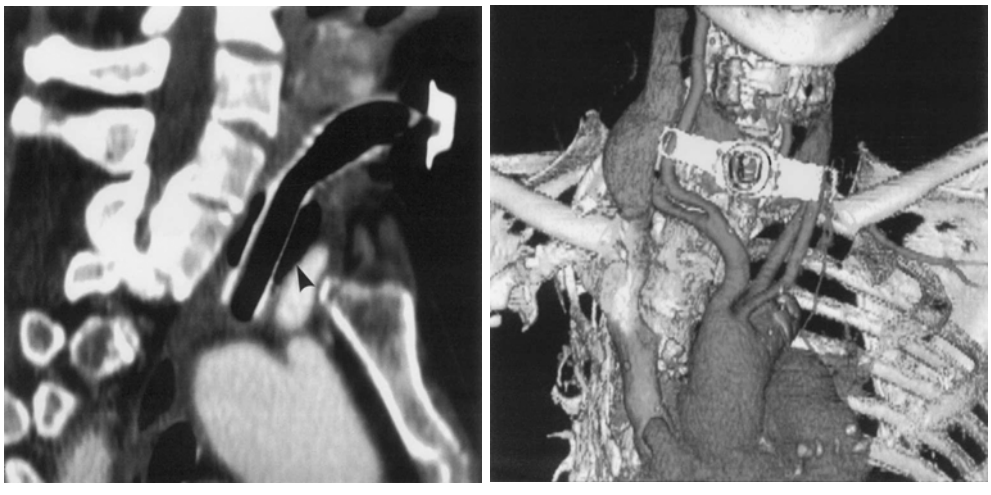
Case

A 70-year-old woman who had undergone left superior lobectomy and thoracoplasty for tuberculosis 30 years previously had been managed with home oxygen therapy for 5 years. She was admitted to our hospital for increasing dyspnea and was intubated in January 1997. She underwent tracheostomy for respiratory management and ventilator support at that time. The cuff volume of the tracheostomy tube had gradually increased during 3 years of mechanical ventilation. In June 2000, massive hemorrhage suddenly occurred through the tracheostomy site. This bleeding was successfully controlled by hyperinflation of the cuff. The patient was immediately examined using a multislice helical CT scanner (Aquilion, Toshiba Medical Company, Tokyo, Japan).

Three-dimensional images reconstructed using an independent workstation system (Zio 2000, AMIN, Tokyo, Japan) enabled us to establish a diagnosis of tracheo-innominate artery fistula without delay (Fig. 1). Emergent surgery was performed by median sternotomy and right oblique cervical incision (Fig. 2A). We selected an operative approach that maintained blood flow through the innominate artery (Fig. 2B). The innominate artery was replaced using a free saphenous



A B

Fig. 1. Images reconstructed by enhanced multislice helical CT.
A: A sagittal multiplanar reformation image at the tracheostomied site. Arrowheads showed thinned site of tracheal wall located between the tracheostomy tube cuff and the innominate artery.
B: Three dimensional image of innominate artery presented by volume-rendering method. It clearly showed a cross anatomical relationship between the tracheostomy tube and the innominate artery.

vein interposition graft while cerebral blood flow was maintained with a temporary left femoral artery-right common carotid artery shunt under systemic heparinization. After blood flow was re-established, the tracheal fistula was primarily repaired with three 3-0 monofilament sutures (Fig. 2C). In addition, a pedicled sternocleidomastoid muscle flap was placed at the suture site (Fig. 2D). We also devised a new postoperative management plan employing a flexible tracheal tube whose depth could easily be adjusted (Adjust Fit, Fuji System Corporation , Tokyo, Japan). Using this tube, we were able to manage the patient's respiratory care without applying excessive cuff pressure to the repaired tracheal wall. The patient's postoperative course was satisfactory. The patient recovered without neurologic sequela. Oral ingestion was attained two weeks after surgery. However, she suddenly died of massive bleeding from the tracheostomy stoma and respiratory failure two months after surgery. Though regrettable, pathological dissection could not be enforced and the cause of bleeding was unclear. However, the rupture of graft anastomosis was considered to be a highly possible cause.

Discussion

Fistula formation between the trachea and the innominate artery is a rare but life-threatening complication of tracheostomy. The mortality rate in patients who develop bleeding from TIF has been reported to be over 85%, and only patients who receive immediate treatment survive.[2] One possible cause of fistula formation is mucosal necrosis due to the pressure exerted by the elbow, tip, or cuff of the tracheostomy tube. The innominate artery has a close anatomical relationship with the trachea. This artery commonly crosses the trachea at the level of the ninth tracheal ring, but the crossing level can vary between the sixth and thirteenth tracheal rings.[3]

In the clinical management of patients with tracheal bleeding, early evaluation of the problem and prompt aggressive therapy are necessary. However, it is not easy to establish the diagnosis of TIF rapidly by conventional examinations such as bronchoscopy, angiography, and so on. Angiography is rarely helpful, is not recommended, and may delay definitive diagnosis and treatment.[2] Bronchoscopy and local wound exploration are frequently inadequate for establishing a diagnosis.[2] If active hemorrhage occurs, a trial of tracheostomy tube cuff hyperinflation is the first choice for temporarily controlling the bleeding.[4] In our case, we were fortunately able to control the bleeding by the cuff hyperinflation maneuver and proceeded to enhanced helical CT study. The reconstruction of three-dimensional images allowed us to establish the diagnosis easily and to decide on immediate surgical

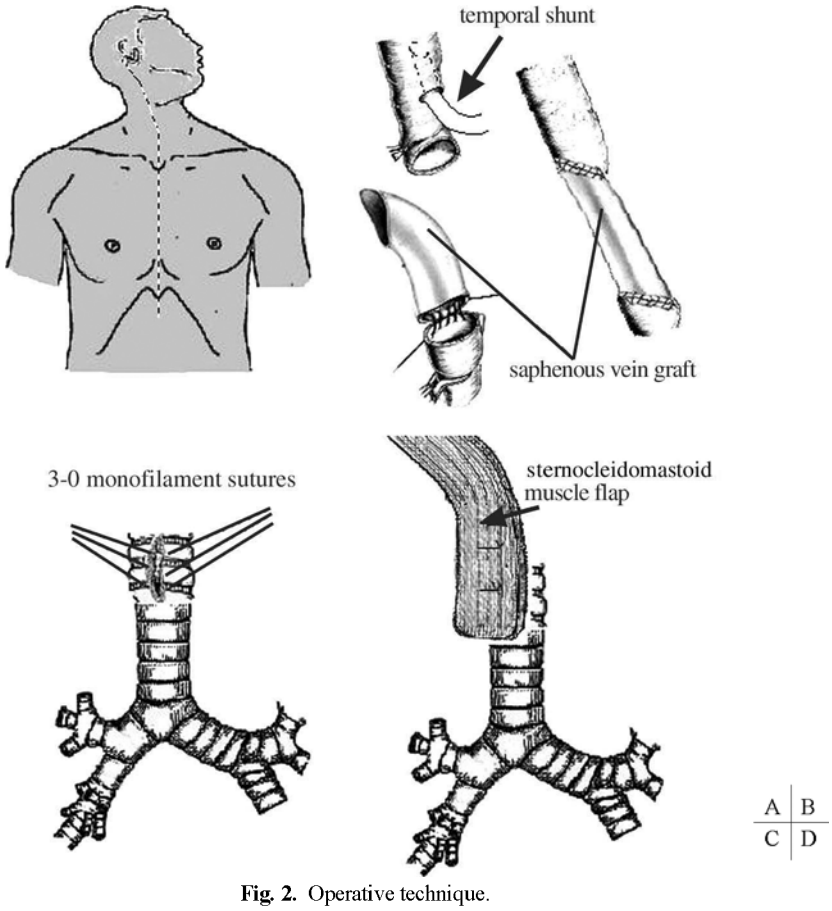


Fig. 2. Operative technique.
A: Skin incision line.
B: Innominate artery reconstruction with interposition using a saphenous vein graft.
C: The tracheal fistula was primarily repaired with three 3-0 monofilament sutures.
D: The suture site was covered with a pedicled sternocleidomastoid muscle flap.

exploration through a median sternotomy for definitive treatment.

With regard to operative techniques, several previous reports have recommended operative procedures to interrupt the flow of the innominate artery and have suggested that reconstruction of the innominate artery should be avoided, even if an interposition technique using autologous tissues is employed.[2,5] Gelman et al. noted differences in long-term survival rates between the "maintaining flow" group and the "interruption" group. They also reported that few neurologic deficits were observed in the patients who underwent resection of the innominate artery.[2]

To avoid surgical infection, extra-anatomical bypass procedures including aortic arch to carotide, carotide to carotide, axillofemoral, and axillo-axillo bypass seem to be preferable. But Gelman et al. reported that a bypass technique did not prolong survival, nor was it necessary to prevent neurological trouble[2]. Besides, we thought it difficult to avoid graft infection of artificial vascular graft even if using an extra-anatomical bypass procedure. To save the patient successfully, we maybe should select a simple ligation technique with resection of the innominate artery. However, we believed that it was inadvisable to employ an approach that carried a risk of significant postoperative neurological morbidity in our case. Because there was no possibility of weaning the patient from mechanical ventilation, even minor neurological sequela would significantly reduce her quality of life, offsetting the benefits of surgical intervention. We also expected the effectiveness of muscle flap procedure in prevention of the graft infection. Although our patient died of massive bleeding from the tracheal tube and respiratory failure 2 months

after surgery, we were able to provide her with good terminal care without neurological deficit.

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