

Successful Repair Using Innominate Vein Flap, Pericardial Flap and Thymus Pedicle Flap for Tracheo-Innominate Artery Fistula

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Tracheo-innominate artery fistula (TIF) is a rare but frequently fatal complication after tracheostomy. Without operation, the mortality is nearly 100% because of acute massive tracheal hemorrhage. Although the survival rate is extremely low, survival is possible only when an immediate operation is performed. Many surgeons have chosen ligation or resection of the innominate artery because repair with blood flow maintained in the innominate artery carries a high risk of postoperative fatal recurrent bleeding. We report on a successful surgical management of one case by patch closure with an innominate vein flap, wrapping of the innominate artery with a pericardial flap, and interposition of a thymus pedicle flap between the innominate artery and the trachea. Our surgical procedure is effective in maintaining the patency of the innominate artery preventing neurological deficits, and in preventing postoperative recurrent bleeding. (Ann Thorac Cardiovasc Surg 2007; 13: 143–6)

Key words: tracheo-innominate artery fistula, innominate vein flap, pericardial flap, thymus pedicle flap

Introduction

Tracheo-innominate artery fistula (TIF) formation is a rare but frequently fatal complication after tracheostomy. The mechanism proposed is of pressure necrosis of the tracheal mucosa caused by the elbow, balloon cuff, or tip of the tracheostomy tube.

Without operation, mortality is nearly 100% due to sudden onset of massive tracheal hemorrhage. Survival is possible only when immediate operation is performed although the survival rate is extremely low. Repair of the innominate artery by primary closure, patch closure, or graft interposition has been reported. However, the incidence of recurrent bleeding and mortality are much higher

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than in the cases treated by ligation, resection, or resection with bypass. We report on the successful surgical management of a patient with a TIF by patch closure with an innominate vein flap, wrapping of the innominate artery with a pericardial flap, and interposition of a thymus pedicle flap between the innominate artery and the trachea.

Case Report

A 29-year-old Japanese man suffered a severe cervical spinal cord injury in a traffic accident. The anterior spinal fusion at C4 to C7, with instrumentation and tracheostomy was performed. He was managed with a tracheostomy tube.

Two years later, he had slight tracheal bleeds and fiberoptic bronchoscopy was performed. Ulceration was detected in the right anterior tracheal wall. Soon after this episode, sudden massive tracheal hemorrhage occurred and he went into hemorrhagic shock. Hyperinflation of



Fig. 1. Angiography had shown an extravasation (arrow) from the innominate artery.

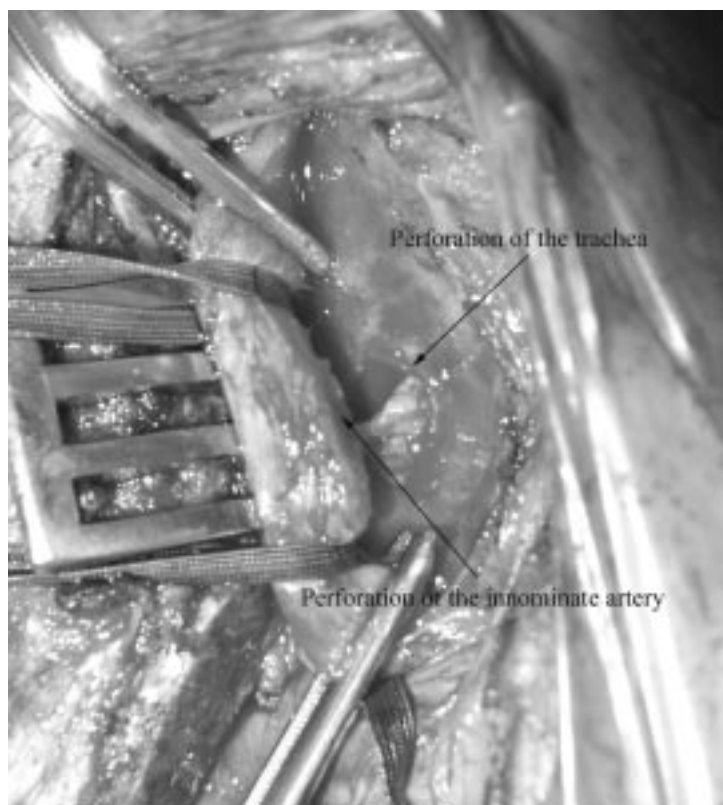


Fig. 2. Perforations were present on the medial surface of the wall of the innominate artery and in the right anterior wall of the trachea.

the tracheostomy tube cuff temporarily controlled the hemorrhage and an angiography was performed. Extravasation was observed in the innominate artery (Fig. 1). Therefore he was diagnosed with TIF formed by mechanical irritation by the tip of the tracheostomy tube. He was urgently transported to our hospital. Under general anesthesia, median sternotomy was performed by a connecting oblique right cervical incision. Marked inflammatory adhesions existed between the innominate artery and the trachea. We placed vascular clamps at the proximal and distal portions of the innominate artery, and the innominate artery and the trachea were separated. Perforations due to deep fistulas, approximately 10 by 5 mm in size, were present on the medial surface of the wall of the innominate artery and in the right anterior wall of the trachea (Fig. 2). Granulation tissue had formed around the perforation sites in the innominate artery and the trachea. We removed portions of the wall of the left innominate vein with an interrupted venous blood flow, and closed a fistula of the innominate artery by a patch closure technique using a vein flap with interrupted nonabsorbable monofilament suture after resecting the granulation tis-

sue around it. Then we closed a defect in the left innominate vein. Although the left innominate vein was slightly stenotic, its blood flow was maintained. We then closed a tracheal fistula primarily by horizontal mattress suture using an absorbable monofilament suture with a pledget. We then completely wrapped the reconstructed innominate artery with an autologous pericardial flap to reinforce the arterial reconstruction. We then obtained a pedicle flap from the right lobe of the thymus with preservation of feeding arteries and thymic veins. We then lifted the thymus pedicle flap and interposed it between the innominate artery and the trachea. We also covered the reconstructed tracheal site with the thymus pedicle flap and fixed the thymus pedicle flap to the tracheal adventitia with interrupted absorbable monofilament sutures (Fig. 3). The blood flow interruption in the innominate artery was 60 min. The patient recovered without any focal neurological deficits.

After three years six months from operation, there has been no recurrent bleeding though a chronic cervical abscess is still present. The thymic fatty tissues remain between the innominate artery and the trachea without ex-



Fig. 3. Reconstruction of the innominate artery by patch closure using the vascular flap from the left innominate vein, and closure of the tracheal fistula.

The reconstructed innominate artery was wrapped with a pericardial flap. A thymus pedicle flap was interposed between the innominate artery and the trachea, and the reconstructed tracheal site was covered with the same material.

hibiting atrophic changes as revealed by computed tomography. Moreover, the left innominate vein maintains patency as demonstrated by enhanced computed tomography.

Discussion

Regarding operative management of TIF, various surgical procedures have been reported. Two basic surgical procedures have been used for the innominate artery. One procedure maintains the blood flow in the innominate artery anatomically either by primary closure,¹⁻³ patch closure with an autologous tissue,¹ replacement with a venous graft,⁴ a vascular prosthetic graft,^{5,6} or implantation of an endovascular self-expanding stent graft.⁷ The other procedures interrupt the blood flow of the innominate artery by simple ligation,^{5,8,9} ligation with a bypass procedure (aorta-right carotid artery⁹), resection of the artery,^{1,2,10-12} or resection of the artery with a bypass procedure (aorto-right common carotid artery,⁸ axillo-axillary,¹³ axillo-femoral¹⁴).

Various surgical procedures have been used for the trachea, including allowing the fistula to undergo natural granulation,¹ by primary closure,^{1,3,6,11-14} by patch clo-

sure with a heterogeneous tissue (bovine pericardial patch,¹⁰ or by patch closure with an autologous tissue (pleural patch,¹ skin and muscle flap²). However, there has been no difference in the outcome when comparing these techniques.¹⁵

There are various cases in which autologous soft tissues have been interposed between the trachea and the innominate artery either using the adjacent muscle and fat tissues, a thymus pedicle flap or omentum.^{2,3,6,10,12}

The incidence of postoperative recurrent bleeding after the interruption of the innominate artery is significantly lower (7%) than after procedures that maintain patency of the artery (60%).⁸ Moreover, the postoperative survival rate at two months is significantly higher in the case of interruption of the innominate artery (64%) than in the case of maintenance of continuity of the artery (10%).⁸ Therefore, most surgeons do not recommend surgical procedures that maintain the patency of the innominate artery.^{8,15} Both ligation and resection of the innominate artery carry a significant risk of neurological complications. The incidence of neurological deficit is comparatively low at approximately 10%.⁴ Furthermore, there is a possibility of the complications of subclavian steal syndrome, and mild weakness of the upper extrem-

ity.¹⁵⁾ Although some surgeons have performed the bypass procedure to prevent neurological complications, it does not seem to prolong survival.¹⁵⁾ Anticoagulant treatment is essential postoperatively, although it may increase the risk of bleeding.

It is inappropriate to replace the innominate artery with a vascular prosthetic graft in a contaminated operative field due to graft infection. The innominate artery should be reconstructed with autologous tissue, which is resistant to infection, and reconstruction of the affected site of the innominate artery should be carried out such that direct contact with the trachea is avoided. We reconstructed the innominate artery by patch closure using an innominate vein flap to prevent stenosis of the innominate artery at the proximal and distal portions of the innominate artery. Our patient recovered without any focal neurological deficits. We did not monitor regional cerebrovascular hemoglobin oxygen saturation (rSO₂) by near-infrared spectroscopy to confirm adequate collateral circulation. But, it is recommended to monitor rSO₂ during operation because perfusion can be resumed temporarily by controlling the anastomotic region with a finger or by using a shunt tube if rSO₂ decreases.

We also reinforced the innominate artery by wrapping a pericardial flap around the reconstructed site. We considered that the reconstruction only by patch closure alone with a vein flap would result in a low resistance to arterial blood pressure and carried the risk of recurrent bleeding. We also interposed the thymus pedicle flap between the innominate artery and the trachea, and covered the tracheal reconstructed site with the same material. There are reports of innominate artery stump coverage with a thymic flap,¹⁰⁻¹²⁾ There is one report of reconstruction by direct closure of the innominate artery and interposition with a thymus pedicle flap.³⁾ The thymus is available in the operative field without requiring an extra incision compared with use of omentum. It is useful not only as a cushion for protection against mechanical irritation but also as immunological vascularized tissue for resistance against infection.

In our patient, the interposed thymus pedicle flap lay between both structures with sufficient gap as shown on CT three years six months after the operation.

Conclusion

In conclusion, our surgical technique is effective in maintaining the patency of the innominate artery to prevent neurological deficits, and in preventing postoperative re-

current bleeding physically and immunologically.

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