Trachea–Innominate Artery Fistula Following Tracheostomy

Successful Repair Using an Innominate Vein Graft

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ABSTRACT This report discusses the first recorded patient in whom a trachea–innominate artery fistula after tracheostomy was treated successfully by resection of the eroded segment of artery followed by graft replacement using the patient's left innominate vein. The mechanism of vessel erosion and its prevention are discussed. Also, suitable methods are presented for obtaining temporary control of the severe hemorrhage associated with a tracheoarterial fistula while simultaneously maintaining an adequate airway.

One of the most serious complications associated with tracheostomy is the development of a fistula between the trachea and a major vessel, usually the innominate artery. Patients with this complication are subject to sudden exsanguinating hemorrhage and asphyxiation due to aspiration of blood. At present, only 8 long-term survivors have been reported in the medical literature [1, 2, 4, 6, 10, 11, 14, 15]; all survivors underwent surgical closure of the innominate artery without any effort to restore normal flow. In this paper we report the first patient in whom a trachea–innominate artery fistula was treated successfully by resection of the eroded artery followed by graft replacement using the patient's left innominate vein.

An 18-year-old woman, a quadriplegic, was brought to the emergency room on August 5, 1974, because of intermittent hemorrhage from a tracheostomy. Bleeding had begun spontaneously a day earlier, and the frequency and amount of hemorrhage had increased progressively.

The patient had been quadriplegic since an automobile accident in 1972. As a result of diaphragmatic respirations alone and an ineffective cough, she had chronic respiratory insufficiency and had been hospitalized on several occasions because of respiratory failure. Tracheostomy had been performed on June 1, 1974, during a hospitalization for treatment of pneumonitis and respiratory failure. The patient's respirations had been assisted for ten days using a cuffed plastic tracheostomy tube connected to a Bennett MA-1 ventilator. Later, the plastic tube had been replaced with a No. 6 metal cannula, which was left in situ at the time of discharge to allow for aspiration of retained tracheobronchial secretions.

Shortly after admission to the emergency room, the patient suffered a major

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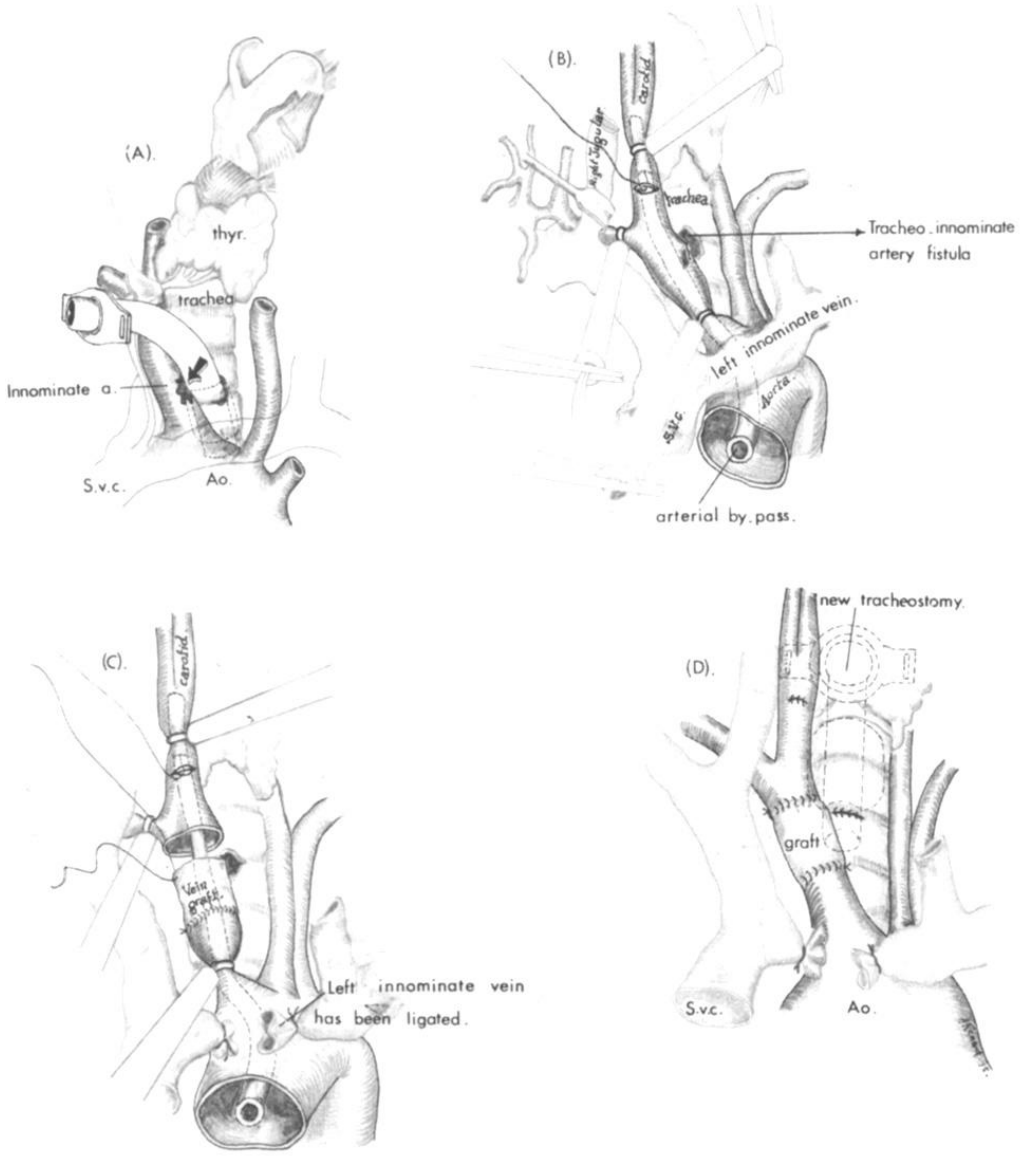
tracheal hemorrhage accompanied by respiratory arrest. The tracheostomy tube rapidly became occluded with clots and was exchanged for a similar tube; following the insertion of a new tube, the bleeding appeared to cease. The lungs were ventilated with an Ambu bag, but there was considerable resistance to air flow, especially in the left lung. Blood pressure at this time was recorded as 70/50 mm Hg. Within a brief period severe bleeding recurred, and the patient was quickly transported to the operating room.

Upon arrival in the operating room, she was unresponsive and her pupils were dilated. Although there was no measurable blood pressure, a thready carotid pulse was present. Bronchoscopy was attempted through the tracheostomy, but continual extreme bleeding precluded satisfactory visualization of the tracheobronchial tree; the hemorrhage, however, was partially controlled by using the bronchoscope as a lever to compress the anterior wall of the trachea against the sternum. While the bronchoscope was held in this position, the anesthesiologist passed a large cuffed endotracheal tube between the vocal cords. After withdrawing the bronchoscope, the endotracheal tube was advanced promptly and the cuff inflated; bleeding subsequently ceased, and the patient was prepared for thoracotomy.

Utilizing a median sternotomy approach, the proximal innominate, right common carotid, and subclavian arteries were mobilized and encircled with umbilical tapes (Figure). After administering heparin (5,000 units) intravenously, the arteries were temporarily occluded by stent tubes placed over the tapes. A transverse incision was made in the carotid artery and an internal shunt tube inserted to provide aortocarotid flow. When flow had been established through the shunt, the innominate artery and trachea were dissected. An opening 5 mm in diameter was found in the posteromedial wall of the artery; the tracheostomy stoma was located in a position contiguous with the 5 mm opening. The eroded segment of artery was resected and replaced with an interpolated vein graft obtained from the left innominate vein and threaded over the shunt tube. Following completion of the graft anastomoses, the shunt tube was removed through the carotid arteriotomy. The tracheotomy was closed with interrupted chromic catgut sutures, and a portion of the sternohyoid muscle was interposed between the trachea and the vein graft. A new tracheostomy was created at a superior level (through the second and third tracheal rings) and a No. 8 cuffed plastic tube inserted.

Postoperatively, the patient required assisted ventilation because of aspiration pneumonitis and respiratory insufficiency. She improved steadily and was discharged in satisfactory condition on September 7, 1974. Prior to discharge, the tracheostomy tube was replaced with an Olympus tracheostomy button to facilitate handling of tracheobronchial secretions. An aortic arch arteriogram made two weeks after operation showed a patent graft and normal filling of the right carotid and subclavian arteries.

Following discharge from the hospital, the patient received training in the use of her accessory respiratory muscles, and the tracheostomy button was removed on December 17, 1974. At the last follow-up examination, January 16, 1975, her general condition was satisfactory and respiratory function seemed adequate.



The operative procedure.

Comment

In 1879, Korte [5] reported the first patient in whom a tracheostomy was complicated by erosion of a major vessel with resultant fatal hemorrhage. Forty-five years later, in 1924, Schlaepfer [13] collected 115 patients with this complication and noted that the incidence was 0.5 to 4.5%. More recent reports by Mathog and co-workers [6] and Rogers [12] indicated that delayed fatal hemorrhage occurs in 0.2 to 1% of patients subjected to tracheostomy. The innominate artery is the vessel most commonly involved; other sources of hemorrhage include the carotid artery, thyroid arteries, aortic arch, and innominate vein [3].

Erosion of a major vessel after tracheostomy is usually caused by pressure necrosis produced by a tracheostomy tube inserted below the fourth tracheal ring. The mechanism of erosion involves either indirect pressure exerted by the tip of

the tube abutting against the anterior tracheal wall or direct pressure resulting from that portion of the tube between the skin and the trachea rubbing on an adjacent vessel; erosion by direct pressure is the more common mechanism. Additional factors that may be responsible for the development of a tracheoarterial fistula are the pistonlike movement of a tracheostomy tube connected to a ventilator, the use of excessive and continuous cuff pressures, infection around the tracheostomy stoma, and malignant neoplastic invasion of a vessel near the trachea.

Hemorrhage from a tracheoarterial fistula generally occurs during the first three weeks after tracheostomy [3]. Although the initial bleeding is frequently massive and persistent, it may be minimal and intermittent, presenting clinically as bloody tracheal secretions. In reported patients in whom premonitory bleeding was noted, massive hemorrhage followed less than one week later, and most often within three days [15].

The surgical treatment of a tracheoarterial fistula involves, first, temporary control of severe hemorrhage while simultaneously maintaining an adequate airway. Sometimes the bleeding site can be tamponaded by inflating the cuff of either a tracheostomy tube or an oral endotracheal tube [2, 4, 6]. Another method, which is probably more often effective, entails opening the tracheostomy wound to allow finger dissection along the outer anterior tracheal wall, followed by manual compression of the innominate artery against the sternum [14]. Bleeding also may be controlled by passing a No. 5 or 6 Fogarty catheter through a brachial arteriotomy into the ascending aorta and then withdrawing the inflated balloon until it lodges in the innominate artery. As soon as possible, the fistula should be approached directly through a median sternotomy. If the innominate or carotid artery is involved, the eroded vessel segment should be resected and blood flow restored whenever possible; packing the bleeding site has not prevented recurrent hemorrhage [8]. A plastic prosthesis is an unsatisfactory replacement for the eroded vessel because of the contamination associated with a tracheostomy and the resultant risk of delayed hemorrhage from an infected graft-artery suture line. In the case reported, the patient's left innominate vein served as a satisfactory replacement for the eroded innominate artery. Alternative methods for restoring flow after surgical closure of the innominate artery include axilloaxillary grafting, axillofemoral grafting, and division of the first portion of the right subclavian artery followed by anastomosis of the proximal end to the proximal innominate artery [9].

Prevention of this serious complication of tracheostomy depends upon careful operative technique and proper postoperative management. A safe tracheostomy requires adequate lighting, suction, and assistance; acute respiratory obstruction is best treated either by inserting an endotracheal tube or by puncturing the cricothyroid membrane with a large-bore needle. Whenever tracheostomy is performed, care should be taken to ensure correct placement of the tube through the second and third tracheal rings. Soft rubber or plastic tracheostomy tubes are preferable since they are less apt to produce tracheal damage. It is also important to provide humidification and make certain that the tracheostomy cuff

is periodically deflated. If ventilatory support is necessary, transmission of the pistonlike movement of the ventilator to the tracheostomy tube can be avoided by using a suitable length of extension tubing between the ventilator and the tube. Mehalic and Farhat [7] have emphasized that hyperirritability, particularly in patients with severe brain injury and a decerebrate posture, may cause repeated tube irritation of the trachea, resulting in erosion of a major vessel. To avoid this complication, such patients should be treated with muscle relaxants, tranquilizers, and cough suppressants. Finally, in those patients in whom a low tracheostomy is recognized, the tracheostomy should be repositioned or removed even though hemorrhage has not yet occurred.

References

1. Bendixen, H. H., Egbert, L. D., and Hedley-White, J. *Respiratory Care.* St. Louis: Mosby, 1965. P 119.
2. Biller, H. F., and Ebert, P. A. Innominate artery hemorrhage complicating tracheotomy. *Ann Otol Rhinol Laryngol* 79:301, 1970.
3. Brantigan, C. O. Delayed major vessel hemorrhage following tracheostomy. *J Trauma* 13:235, 1973.
4. Ivankovic, A. D., Thomsen, S., and Rattenborg, C. C. Fatal hemorrhage from the innominate artery after tracheostomy. *Br J Anaesth* 41:450, 1969.
5. Korte, W. Uber einige seltenere Nachkrankheiten nach der Tracheotomie wegen Diphteritis. *Arch Klin Chir* 24:238, 1879.
6. Mathog, R. H., Kenan, P. D., and Hudson, W. R. Delayed massive hemorrhage following tracheostomy. *Laryngoscope* 81:107, 1971.
7. Mehalic, T. F., and Farhat, S. M. Tracheoarterial fistula: A complication of tracheostomy in patients with brain stem injury. *J Trauma* 12:140, 1972.
8. Myers, R. S., and Pilch, W. H. Temporary control of tracheal–innominate artery fistula. *Ann Surg* 170:149, 1969.
9. Myers, W. O., Lawton, B. R., and Sautter, R. D. An operation for tracheal–innominate artery fistula. *Arch Surg* 105:269, 1972.
10. Rashkind, R., Glover, B., Arbegast, M. R., and Comer, T. P. Control of hemorrhage from the innominate artery complicating tracheostomy through a suprasternal approach. *Vasc Surg* 7:265, 1973.
11. Reich, M. P., and Rosenkrantz, J. G. Fistula between innominate artery and trachea. *Arch Surg* 96:401, 1968.
12. Rogers, L. A. Complications of tracheostomy. *South Med J* 62:1496, 1969.
13. Schlaepfer, K. Fatal hemorrhage following tracheotomy for laryngeal diphtheria. *JAMA* 82:1581, 1924.
14. Utley, J. R., Singer, M. M., Roe, B. B., Fraser, D. G., and Dedo, H. H. Definitive management of innominate artery hemorrhage complicating tracheostomy. *JAMA* 220:577, 1972.
15. Weissman, B. W. Tracheo–innominate artery fistula. *Laryngoscope* 84:205, 1974.