SURGICAL APPROACHES TO MEMBRANOUS TRACHEAL WALL LACERATIONS

Alfredo Mussi, MD
Marcello Carlo Ambrogi, MD
Gianfranco Menconi, MD
Alessandro Ribechini, MD
Carlo Alberto Angeletti, MD

Background: Smaller postintubation tracheal tears are often misdiagnosed and, when recognized, they are effectively managed in a conservative fashion. Large membranous lacerations, especially if associated with important manifestations, require immediate surgical repair. We report our experience over the past 7 years.

Methods: From 1993 to 1999, 11 patients with a postintubation posterior tracheal wall laceration were treated in our institution. One patient was male and 10 were female, with a mean age of 68 years. Ten patients underwent orotracheal intubation under general anesthesia for elective surgery, 4 of whom were treated with a double-lumen selective tube. One patient underwent emergency intubation because of anaphylactic shock. In 9 cases the tracheal tear was promptly repaired, by way of a thoracotomy in 4 and by way of a cervicotomy and longitudinal tracheotomy in 5. In 2 cases the tear was small and was consequently managed conservatively.

Results: All surgical procedures proved effective in repairing the laceration, and there was no mortality or morbidity in the perioperative period. Early and late endoscopic follow-up showed no signs of tracheobronchial stenosis.

Conclusions: When repair of membranous tracheal laceration is required, the surgical approach should be through a thoracotomy if the tear involves the distal trachea, a main stem, or both, and through a cervicotomy when the laceration is located in the proximal two thirds of the trachea. Performing a longitudinal tracheotomy to reach and suture the posterior tracheal wall is a reliable, quick, and safe procedure, and it avoids lateral and posterior dissection of the trachea. (J Thorac Cardiovasc Surg 2000;120:115-8)

Posterior tracheal wall laceration is a rare and serious complication of general anesthesia. It may occur in association with apparently uneventful tracheal intubations, and the first signs of its presence generally are hemoptysis and subcutaneous emphysema.¹⁻⁴ Diagnosis is usually made by means of bronchoscopy, which also obtains information about certain features of the lesion, such as site, length, and depth. Although smaller and

superficial tears may heal spontaneously, deeper and longer lacerations, especially if the patient has symptoms, require prompt surgical repair.^{1,4,5} We review 11 cases of membranous tracheal laceration consequent to endotracheal intubation that we have treated during the past 7 years. Nine were immediately repaired, 4 through thoracotomy and 5 through a simple and safe cervical approach recently reported.⁴

Patients and methods

From March 1993 to March 1999, 11 patients received our attention because of suspicion of membranous tracheal wall rupture related to endotracheal intubation. Ten patients were female and 1 was male, with a mean age of 68 years (range, 35-92 years). The orotracheal intubation related to the tear was carried out under general anesthesia for elective surgery in 10 patients and as an emergency procedure as a result of anaphylactic shock in 1 patient. In 4 patients intubation was with a double-lumen selective tube.

A tracheal tear occurred during the upper lobectomy for lung cancer in 1 case and during the removal of a giant poste-

From the Division of Thoracic Surgery, Cardiac and Thoracic Department, University of Pisa, Pisa, Italy.

Received for publication Nov 10, 1999; revisions requested Dec 23, 1999; revisions received March 15, 2000; accepted for publication March 15, 2000.

Address for reprints: Carlo A. Angeletti, MD, Division of Thoracic Surgery, Cardiac and Thoracic Department University of Pisa, Via Paradisa, 2, 56124—Pisa, Italy

(E-mail: c.angeletti@dc.med.unipi.it).

Copyright © 2000 by The American Association for Thoracic Surgery

0022-5223/2000 \$12.00 + 0 12/1/107122

doi:10.1067/mtc.2000.107122

Table I. *Clinical features and treatment of the 11 postintubation tracheal tears*

<i>Patient No. (age [y], sex)</i>	<i>Intubation</i>	<i>Location</i>	<i>Length (mm)</i>	<i>Signs-symptoms</i>	<i>Treatment</i>	<i>Approach</i>
1 (35, F)	Orotracheal	4 cm above carina	30	Hemoptysis, subcutaneous emphysema, pneumomediastinum	Surgical	Cervicotomy
2 (74, F)	Orotracheal	5 cm above carina	30	Dyspnea, subcutaneous emphysema, pneumomediastinum	Surgical	Cervicotomy
3 (65, F)	Orotracheal	4.5 cm above carina	30	Dyspnea, subcutaneous emphysema, pneumomediastinum	Surgical	Cervicotomy
4 (92, F)	Orotracheal	3.5 cm above carina	50	Hemoptysis, subcutaneous emphysema, pneumomediastinum	Surgical	Cervicotomy
5 (69, F)	Orotracheal	3.5 cm above carina	40	Subcutaneous emphysema, pneumomediastinum	Surgical	Cervicotomy
6 (83, F)	Orotracheal	Trachea and right main bronchus	45	Subcutaneous emphysema, pneumomediastinum	Surgical	Right thoracotomy
7 (65, F)	Orotracheal	Trachea and right main bronchus	40	Hemoptysis, subcutaneous emphysema, pneumomediastinum	Surgical	Right thoracotomy
8 (65, F)	Selective double lumen	Trachea and left main bronchus	50	Pneumomediastinum, desaturation bleeding	Surgical	Right thoracotomy
9 (55, F)	Selective double lumen	Trachea and right main bronchus	55	Pneumomediastinum, desaturation bleeding	Surgical	Right thoracotomy
10 (72, M)	Selective double lumen	2 cm above carina	20	Hemoptysis	Conservative	—
11 (77, F)	Selective double lumen	4 cm above carina	25	Dyspnea	Conservative	—

rior mediastinal goiter in the another, both operations being performed through a right thoracotomy. In these patients the anesthesiologist reported recurrent episodes of desaturation and bleeding from the tracheal tube. Meanwhile, during the operation, the surgeon observed the appearance of mediastinal emphysema. A bronchoscope was immediately inserted through the double-lumen tube, and it revealed a juxtacarinar membranous tracheal tear involving the right main bronchus in 1 patient and the left main-stem bronchus in the other. In both cases surgical repair was directly performed through the same right thoracic incision.

In the other 9 patients the most common signs and symptoms were hemoptysis, dyspnea, and subcutaneous emphysema (Table I). These symptoms usually developed just after extubation and always within 12 hours of extubation. Chest radiography revealed a pneumomediastinum in 7 patients. Bronchoscopy confirmed the clinical suspicion in 8 patients. In 1 patient the diagnosis was made during bronchial aspiration. Two patients, both of whom had small mucosal tears (ie, not gaping during respiratory air flow) and no signs or symptoms of full-thickness involvement of the tracheal wall (eg, subcutaneous emphysema and pneumomediastinum), were treated conservatively.

The other 7 patients, who had deeper and longer lacerations, the edges of which gaped during respiratory air flow, and who had important clinical manifestations, underwent surgical repair within 12 hours (mean, 6 hours) of the intubation. In 2 patients the tear involved the distal trachea and the right main-stem bronchus posteriorly for a length of 40 and 45 mm, respectively. In the other 5 patients the lacerations

were in the proximal two thirds of the trachea, and the mean length was 36 mm (range, 30-50 mm). All patients underwent general anesthesia and were again intubated with bronchoscopic guidance. The first 2 were intubated with a double-lumen tube (Bronco-Cath; Mallinckrodt Medical, Cornamaddy, Athlone, County Westmeath, Ireland) for a right posterolateral thoracotomy, and the other 5 patients, who underwent cervicotomies, were intubated with a 5.5-mm inner diameter single low-pressure cuffed oro-tracheal tube (Bivona Aire-cuf, Gary, Ind). In the patients treated through the thoracic incision, the distal trachea and the involved main-stem bronchus were isolated posteriorly, and the tear was repaired by means of interrupted absorbable 4-0 Maxon sutures (Davis & Geck, Wayne, NJ). In the other 5 patients we used an approach recently reported by Angelillo-Mackinley.⁴ A small collar incision was performed 2 cm above the sternum with the neck hyperextended, as is done for mediastinoscopy. A minimal dissection allowed us to reach the pretracheal space, and the thyroid isthmus was sectioned in all but 1 case. The anterior tracheal wall was then incised longitudinally along the midline, for the length of 4 to 7 rings, in exact correspondence to the injury, with a fiberoptic bronchoscope used as a guiding tool. Tracheotomy edges were retracted laterally, and while the oro-tracheal tube was withdrawn, a second 4.5-mm inner diameter sterile low-pressure cuffed flexible armored endotracheal tube was inserted into the distal airway through the tracheal incision across the field of operation. No jet ventilation was used. During the suture, the endotracheal tube was withdrawn several times to adequately expose the tracheal tear. The laceration was

repaired with a 4-0 Dexon II running suture (Davis & Geck), generally starting from the distal end of the tear. While the patients were in an apneic state, the anesthesiologist monitored their vital signs to decide when to ventilate again. Once the laceration was repaired, the endotracheal tube was withdrawn from the field of operation, and the original orotracheal tube was advanced by the anesthesiologist beyond the suture. The longitudinal tracheotomy was closed by using 3-0 Dexon II interrupted crossed stitches.

Results

All surgical procedures proved effective. There was no mortality or morbidity involved. In the 2 patients in whom the tracheobronchial tear was discovered after the initial operation, the average duration of the surgical procedure through an elective right thoracotomy was 110 minutes. On the other hand, the mean time required for the cervicotomy procedure was less than 1 hour. All patients were immediately extubated at the end of the surgical procedure.

The postoperative course was uneventful in all cases, and the patients were discharged on average after 5.7 days (range, 3-8 days). The mean postoperative hospital stay was 4.6 days in the 5 patients who underwent the cervical approach (range, 3-6 days). Endoscopic follow-up after 10, 30, and 60 days showed a perfect healing process of the laceration in all cases, with no symptoms or signs of tracheal or bronchial stenosis.

Discussion

Tracheal laceration is a rare complication of general anesthesia, which generally involves the posterior membranous wall. The relatively high incidence in our series (11 cases in 7 years) may be explained by the fact that ours is a tertiary referral center for tracheal surgery in our country. Similar to our experience, in the literature tracheal lesions have been reported to be associated with both double-lumen selective and single-lumen intubations, and women seem to be more prone to the complication than men.^{1,2,4-6} Many factors may be responsible for producing the lesion: repeated attempts at a difficult intubation,^{7,8} as in one of our cases; the presence of tracheal abnormalities⁹; and overdistention or rupture of the tube cuff.^{5,10} However, many times a tracheal laceration occurs after an intubation carried out with no apparent difficulty,^{1,2,4} as in the other cases of our report.

The diagnosis is not a difficult one if the physician keeps in mind such a possibility. The first signs often appear immediately after the extubation or within the first 12 hours.^{1,4} These symptoms are hemoptysis; subcutaneous emphysema of the head, neck, and upper chest^{1,4}; and, in severe cases, dyspnea and cyanosis.¹¹

Chest x-ray films usually show a pneumomediastinum, as in 7 of our patients, and in some cases, especially when the laceration is in the lower part of the trachea or has extended to one main bronchus, a pneumothorax.^{12,13}

Tracheobronchoscopy can confirm the diagnosis and establish the location and the extent of the tear, thus allowing the surgeon to plan the correct surgical approach.² When a tracheoesophageal fistula is suspected, an esophagoscopy is also required.¹⁴

In the literature several isolated cases of postintubation tracheal tears managed successfully by means of conservative therapy have been reported.^{6,11,15} They were mainly small tears in patients in stable condition with at most minimal and nonprogressive manifestations, such as subcutaneous emphysema, pneumomediastinum, and pneumothorax. We likewise treated 2 patients in our series with these same features. In these cases endoscopic findings, rather than clinical manifestations, have influenced our strategy of treatment. We believe that only short and superficial tears may spontaneously heal without a significant risk of early and late complications.

Still, definitive single-stage surgical repair remains the preferred choice of treatment in most cases of tracheobronchial laceration. It should be performed as soon as possible to avoid both early complications, such as descendent mediastinitis, and belated sequelae, such as tracheal stenosis.^{2,3,5,12}

Juxtacarinal membranous tracheal lacerations are generally managed through a right thoracotomy, especially if they involve a main bronchus. This was our approach in 4 patients with a tracheobronchial lesion. On the other hand, when the tear involves the proximal two thirds of the posterior tracheal wall, a cervical approach would be more fitting,¹⁶ as in the case of the remaining 5 patients in our report. Traditional technique would provide for a left cervicotomy, sometimes extended to a sternal split, followed by a lateral and then posterior paratracheal dissection to isolate the trachea and to reach the membranous wall for suturing.^{5,16} In contrast, in all our patients who underwent the cervical approach, we used the technique reported by Jacobs in 1978 and recently revised and modified by Angelillo-Mackinley,⁴ with a slight twist on the airway management. Jacobs and colleagues¹⁴ first reported 2 cases of posterior tracheal laceration as a complication of tracheostomy that were promptly repaired with a single-layer closure through the same tracheotomy. In a case report, Angelillo-Mackinley described suturing a tear through a cervical mediastinoscopy-like approach and making a vertical incision in the anterior wall of the trachea. His patient was intubated with a small single-

lumen tube retracted laterally to allow the suturing of the tear. Our approach was almost the same, but we substituted the orotracheal tube with a smaller one inserted into the distal trachea across the field of operation, as is usually done for tracheal resection and reconstruction. This allowed us to easily alternate suturing with ventilation and afforded us optimal maneuverability in repairing the distal end of the laceration when the tube was removed and the patient was in an apneic state. Moreover, during this procedure, we realized that it may be possible to repair tears extending all the way to the carina without the necessity of a sternal split.

In conclusion, we concur with those authors who opt for conservative management in patients with minimal and nonprogressive symptoms and signs and with small tears that do not gape during respiration. However, these cases are the exception and not the rule. Early surgical repair is the mainstay of treatment; it offers good results, and prognosis generally depends on the underlying disease and not on the injury itself. When surgical repair is required and the tear is above the carina, we suggest the transcervical-transtacheal approach. This minimally invasive technique, although very quick and easy to perform, provides excellent results and avoids lateral and then posterior dissection of the trachea (necessary to reach the membranous tracheal wall) and consequent exposure of the recurrent laryngeal nerve to injury.

REFERENCES

1. Kumar SM, Pandit SK, Cohen PJ. Tracheal laceration associated with endotracheal anaesthesia. *Anaesthesiology* 1977;47:298-9.
2. Orta DA, Cousar JE, Yergin BM, Olsen GN. Tracheal laceration with massive subcutaneous emphysema: a rare complication of endotracheal intubation. *Thorax* 1979;34:655-69.
3. D'Odemont JP, Pringot J, Goncette L, Goenen M, Rodenstein DO. Spontaneous favourable outcome of tracheal laceration. *Chest* 1991;99:1290-2.
4. Angelillo-Mackinley T. Transcervical repair of distal membranous tracheal laceration. *Ann Thorac Surg* 1995;59:531-2.
5. Massard G, Roug C, Dabbag A, Kessler R, Hentz JG, Roeslin N, et al. Tracheobronchial lacerations after intubation and tracheostomy. *Ann Thorac Surg* 1996;61:483-7.
6. Borasio P, Ardisson F, Chiampo G. Post-intubation tracheal rupture. A report on ten cases. *Eur J Cardiothorac Surg* 1997;12:98-100.
7. Serlin SP, Daily JR. Tracheal perforation in the neonate: a complication of endotracheal intubation. *J Pediatr* 1975;86:596-7.
8. Ross HM, Grant FJ, Wilson RS, Burt ME. Nonoperative management of tracheal laceration during endotracheal intubation. *Ann Thorac Surg* 1997;63:240-2.
9. Thompson DS, Read RC. Rupture of the trachea following endotracheal intubation. *JAMA* 1968;204:995-7.
10. Eichler W, Sedumund-Adib B, Schumacher J, Klotz KF. Diagnosis, procedures and conservative therapy of a bronchial rupture after intubation with double-lumen tube. *Anesthesiol Intensivmed Notfallmed Schmerzther* 1999;34:66-70.
11. Kirsh MM, Orringer MD, Behrendt DM, Sloan H. Management of tracheobronchial disruption secondary to non-penetrating trauma. *Ann Thorac Surg* 1976;22:93-101.
12. Zimmerman JE, Dumbar BS, Klingenmaier CH. Pneumothorax during respiratory therapy. *Med Ann Dist Columbia* 1974;43:107-9.
13. Schultz SC, Hammon JW, Turner CS, McGuirt WF, Nelson JM. Surgical management and follow-up of a complex tracheobronchial injury. *Ann Thorac Surg* 1999;67:834-6.
14. Jacobs JR, Thawley SE, Abata R, Sessions DG, Ogura JH. Posterior tracheal laceration: a rare complication of tracheostomy. *Laryngoscope* 1978;88:1942-6.
15. Marty-An CH, Picard E, Jouquet O, Mary H. Membranous tracheal rupture after endotracheal intubation. *Ann Thorac Surg* 1995;60:1367-71.
16. Grillo HC. Surgical approaches to the trachea. *Surg Gynecol Obstet* 1969;129:347-52.

Timely

The Journal of Thoracic and Cardiovascular Surgery delivers the information you need now. Articles usually appear within four months of acceptance.