Thoracic Cancer ISSN 1759-7706

ORIGINAL ARTICLE

Surgical treatment for bronchopleural fistula with omentum covering after pulmonary resection for non-small cell lung cancer

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Keywords
bronchial stump, bronchopleural fistula, lung cancer, surgical treatment.

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Received: 24 May 2012;
accepted 25 June 2012.

doi: 10.1111/j.1759-7714.2012.00161.x

Abstract

Background: Bronchopleural fistula is an especially severe complication with a high mortality rate. We investigated the efficiency of our surgical treatments for this severe complication.
Methods: From January 2007 to December 2009, standard surgical resections and systematic lymph node dissections for non-small cell lung cancer (NSCLC) were performed on 1178 patients at our institution. Eight patients developed bronchopleural fistulas during the postoperative follow-up period, and received reoperations. Seven patients underwent additional pneumonectomies, and the omental flap, which was mobilized using a transdiaphragmatic harvesting technique through the usual thoracotomy, was used to cover postpneumonectomy bronchial stump. The other patient, who had received right side pneumonectomy and systemic lymph node dissection, received omental flap stuffing and covering without reclosure of the stump or carinal plasty.
Results: Bronchopleural fistulas after standard surgical resections and systematic lymph node dissections for NSCLC were observed in eight patients (0.68%) in our study. The period between pulmonary resection and the appearance of bronchopleural fistula ranged from eight to 19 days (median 11 days). Repairing of the bronchial fistula was successful in all eight patients and no development of late fistula was found during the follow-up period. Postoperative hospital stay for undergoing omentoplasty to repair the bronchial fistula ranged between 11 and 23 days (median 15 days). There were no complications related to the omentoplasty procedure.
Conclusion: Transdiaphragmatic harvesting technique of omental flap through a thoracotomy is safe and technically feasible. Surgical treatment for postoperative bronchopleural fistula with omental flap covering is effective.

Introduction

Although advances in perioperative management have improved the surgical outcome after pulmonary resection, bronchopleural fistula still remains one of the most serious complications of pulmonary resection and has been identified as an independent predictor of mortality.[1] Different managements, such as surgical and non-operative treatments, have been evaluated. This study was initiated to investigate the efficiency of our surgical treatments for bronchopleural fistula.

Material and methods

Clinical data

Our hospital's Ethics Committee approved the retrospective study. From January 2007 to December 2009, standard surgical resections and systematic lymph node dissections for non-small cell lung cancer (NSCLC) were performed on 1178 patients at our institution. Among them, 58 patients received pneumonectomy. Eight patients developed bronchopleural fistulas during the postoperative follow-up period. Fever and

hyperleukocytosis presented in seven patients, and altered sputum was found in one patient. Bronchopleural fistula was confirmed by chest X-ray, chest computed tomography (CT), and bronchofiberscopy in all these cases. The clinical data, obtained from the clinical records, including age, sex, side, histology, *p*-stage, N2, medical comorbidities, closure methods of bronchial stump, coverage of the bronchial stump, induction therapy, residual tumor, and the type of pulmonary resection, are shown in Table 1. Conservative treatments, such as pleural drainage and antibiotics, were initiated upon bronchopleural fistulas when diagnosed. Bronchoscopic embolizations were applied in five patients whose systemic inflammations were mild, but proved to be unsuccessful. All eight patients received reoperations. Seven patients underwent additional pneumonectomies after operative explorations, as resection and reclosure in bronchial stump insufficiency were impossible due to length limitation and obvious inflammation. The omental flap, which was mobilized through a radial incision in the diaphragm through the usual thoracotomy, was used to cover the postpneumonectomy bronchial stump. The other patient, who had received right side pneumonectomy and systematic lymph node dissection 11 days before, received stump debridement and omental flap stuffing and covering (Figs 1, 2). The omental flap was then fixed to the bronchial stump by interrupted suture avoiding its slippage and shift. The aperture was not reclosed in this patient because of obvious congestion and edema in the bronchial stump. The length of the right main bronchus was limited. Carinoplasty was also avoided in this patient due to its high postoperative mortality.[2] For all eight patients, upper and lower drainage tubes were placed before the operations were completed. Continuous flushing from the upper drainage with normal saline solution was initiated until the solution, which flowed out from the lower drainage tube, became clear.

Table 1 Cases of postoperative bronchopleural fistula

Case	1	2	3	4	5	6	7	8
Age	56	71	53	66	69	57	69	55
Sex	Male	Male	Male	Male	Male	Female	Male	Female
Histology	Sq	Sq	Sq	Sq	Sq	Adeno	Adeno	Sq
p-stage	IIIA	IIIB	IIIA	IIIA	IIIA	IIB	IIIA	IIIB
N2	(+)	(+)	(+)	(+)	(+)	(–)	(+)	(+)
Induction therapy	Chemo	Chemo+RT	(–)	Chemo	Chemo	(–)	Chemo	Chemo
Closure method of bronchial stump	M S	Ligation	M S	Ligation	M S	Stapler	Stapler	M S
Coverage of the bronchial stump	No	Pericardial fat	No	Pericardial fat	No	Inter-costal muscle	No	Inter-costal muscle
Residual tumor	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)
Comorbidity		diabetes				diabetes		
Side	Right	Right	Left	Right	Left	Right	Right	Right
Pulmonary resection type	Pneumonectomy	Upper lobectomy	Upper lobectomy	Upper lobectomy	Sleeve resection of the upper lobe	Middle and lower bilobectomies	Upper lobectomy	Sleeve resection of the upper lobe

Adeno, adenocarcinoma; Chemo, chemotherapy; M S, manual suture; RT, radiation therapy; Sq, squamous cell carcinoma.

Transdiaphragmatic harvesting technique of the omentum

D'Andrilli *et al*.[3] detailed this technique previously. Our technique, with little modification compared with previous reported, had been performed in our clinic for more than five years. Briefly, the diaphragm incision about five centimeters was performed radially between its anterior insertion and the central tendon through the usual thoracotomy. Oval forceps were used to slide through the diaphragm into the abdominal cavity. During this procedure the omentum should first be confirmed to be free of adhesions. Then the greater omentum could be gently retracted through the diaphragm into the chest. The transverse colon was then identified and its omental insertion was divided as extensively as possible. In the chest cavity the most distal omental extremity was identified by gentle traction and was subsequently isolated carefully

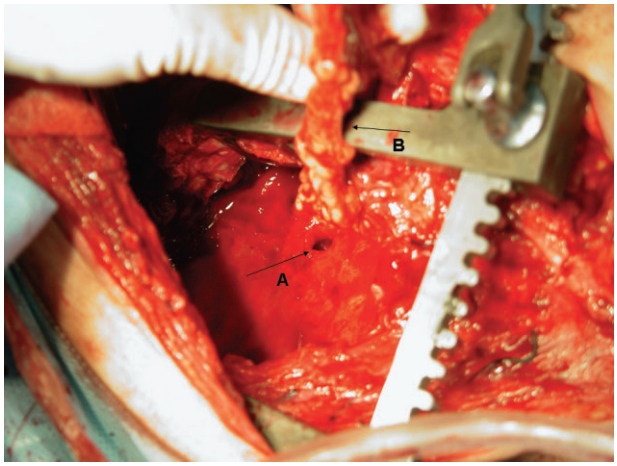

Figure 1 The primary bronchial stump was debrided (arrow A) and the omental flap (arrow B), which was mobilized through the usual thoracotomy, was prepared for stuffing and covering of the bronchial stump.

respecting its vascular supply. After assuring that the omental flap reaching the bronchial stump had no traction on the colon or stomach, the omentum was sutured to the bronchial stump in the usual fashion. The diaphragmatic incision was then closed with heavy silk sutures leaving a wide enough opening to prevent strangulation of the omentum. Tension on the omental flap was further relieved by fixing it to the diaphragmatic opening with interrupted sutures. Recommendation should be pointed out that the omentum harvested by this technique was only appropriate to reinforce the bronchial stump, and could never be large enough to occupy the whole pleural cavity.

Results

Bronchopleural fistulas after standard pulmonary resections and systematic lymph node dissections for NSCLC were

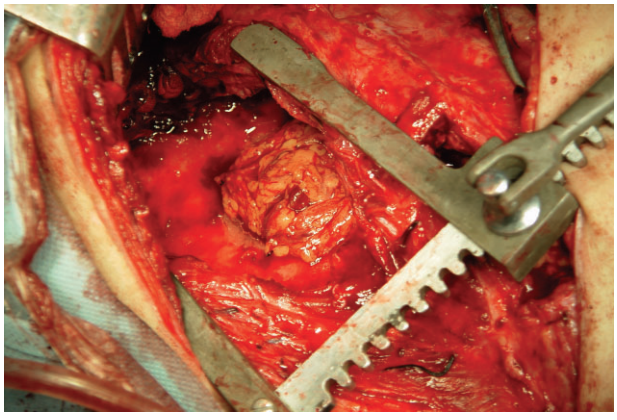

Figure 2 The bronchial stump was stuffed and covered with the omental flap without reclosure of the primary bronchial stump.

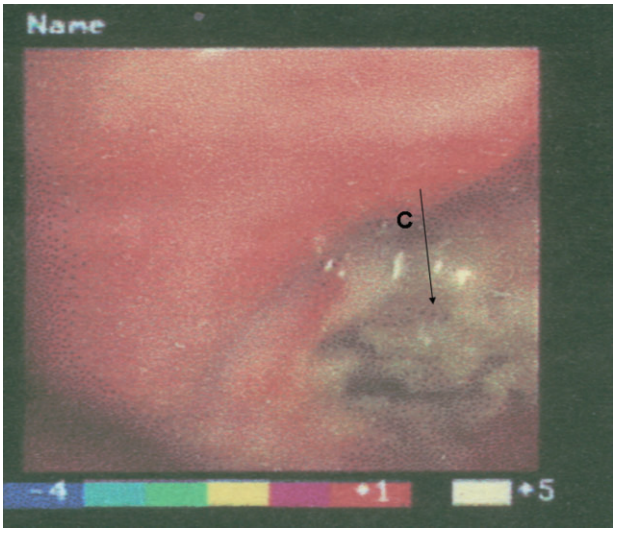

Figure 3 Bronchofiberscopy revealed a well-healed bronchial stump three months postoperatively, and the great omentum (arrow C) survived well.

observed in eight patients (0.68%) in our study. The period between pulmonary resection and the appearance of bronchopleural fistula ranged from eight to 19 days (median 11 days). Repairing of the bronchial fistula was successful in all eight patients and no development of late fistula was found during the follow-up period. One of the patients, who received stump debridement and omental flap stuffing, recovered well. No displacement of omental flap was found in this patient, and bronchofiberscopy was performed three months postoperatively revealing a well-healed bronchial stump (Fig. 3). Postoperative hospital stay for undergoing omentoplasty to repair the bronchial fistula ranged between 11 and 23 days (median 15 days). There were no complications related to the omentoplasty procedure. None of the patients reported digestive or abdominal symptoms. No herniation of abdominal organs into the chest occurred in any patient.

Discussion

Bronchopleural fistula is one of the most serious complications after pulmonary resection for NSCLC. The reported incidence of bronchopleural fistula is 0.4% to 4% after lobectomy[4] and 1.5% to 15% after pneumonectomy.[5] Although modern surgical techniques have decreased the incidence of bronchopleural fistula, the significant mortality in patients with bronchopleural fistula still remains a major problem for thoracic surgeons. It is reported[4–6] that certain risk factors such as right pneumonectomy, chronic obstructive pulmonary disease, preoperative pleuropulmonary infection, prolonged steroid therapy, suturing technique (manual or mechanical suturing), extended lymph node dissection,

residual tumor at the bronchial stump, induction therapy, and hyperglycemia, may contribute to bronchopleural fistulas. Several risk factors were also presented in our series. However, our series was too small to make any definitive statement on the preference for either technique, or to determine definitive predictive factors for postoperative bronchopleural fistula development. Nevertheless, we could deduce that induction therapy, which was given in six patients (75%), might be correlated with postoperative bronchopleural fistulas, as we knew blood supply was essential for healing of the bronchial stump. Chemotherapy and radiochemotherapy had been shown to have negative effects on bronchial mucosal blood flow. Induction therapy, especially radiation therapy, would decrease the blood flow in the radiation field and weaken wound healing ability.[7] Moreover, six out of seven patients who were classified N_2 postoperatively had bulky N_2 disease, and received more extensive dissection around the main bronchus with potential devascularization of the bronchial stump. Local ischemia following extensive lymph node dissection might be one of the causes of wound-healing failure at the bronchial stump, leading to the development of bronchopleural fistulas.[8] Interesting results in our study were that seven out of eight patients developed bronchopleural fistulas after lobectomies, and only one after pneumonectomy. This fact was incompatible with previous reports, as the incidence of bronchopleural fistula was obviously higher after pneumonectomy for various reasons.[6,8] This might be explained in that were far fewer patients who underwent pneumonectomy during this period, than those who underwent lobectomies. In our department, clinical application of lung-saving operations, such as lung autotransplantation technique[9] and bronchovascular double sleeve lobectomy, were promising.

Stump coverage is well recognized as a crucial means of decreasing the risk of bronchopleural fistula.[1] Prophylactic coverage of the bronchial stump with autologous tissue was performed in four patients in our study, who were treated with either neoadjuvant radio-chemotherapy or extensive peribronchial dissection during surgery. Many materials for covering the bronchial stump have been investigated[1,10] previously, including pericardial fat pads, diaphragm flaps, pedicled intercostal muscle flap, and pleura. Controversy remains over which coverage technique and what kind of materials should be selected. A major complication of diaphragm flaps was visceral herniation that had to be treated with Mersilene mesh to close the diaphragmatic defect.[11] The pedicled intercostal muscle flap was often used for prevention of bronchopleural fistula, but the retraction of muscle flaps minimized their covering potential, and the potential for developing heterotopic ossification based on the periosteum of the rib might cause severe problems.[12,13] Both of these techniques led to a longer surgical duration and, moreover, weakening of the chest wall or diaphragmatic muscle could cause respiratory insufficiency during the postoperative course. The pericardial fat pads and pleura, which were also widely used in clinical practice, were less vascularized compared with the pedicled tissue. Utilization of greater omental flaps has been proven to be more effective in the management of several complex thoracic surgical problems.[3,14,15] It has been particularly successful in aiding the healing of bronchial stumps at high risk for dehiscence after pneumonectomy or as a means to reinforce the repair of a bronchopleural fistula, especially in the presence of empyema. Although very satisfactory results have been obtained also with the use of muscular, pericardial fat, and diaphragmatic flaps,[1,10,11] the omental tissue revealed some peculiarities that promote its utilization in this setting. Firstly, the omentum has a rich vascular supply assuring adequate oxygen and antibiotic delivery. Secondly, the omentum delivers potent angiogenic factors, which have been proven to improve neovascularization of the bronchial suture lines in experimental models.[16] No such factors have been found in the muscle. Moreover, the omental transposition does not have the disadvantage of producing chest wall deformities and impairing the muscle function, as seen with the use of major muscle flaps. In our series, repair of the bronchial fistulas with great omentum covering was proven effective in all eight patients and no development of late fistula was found during the follow-up period. The satisfactory result achieved in the patient who received stump debridement and omental flap stuffing, in particular, revealed the incomparable advantage of omental covering.

Traditional omental flap transposition, however, has the disadvantage of extending the surgical procedure into the abdomen, requiring additional laparotomic access. Most often, the omentum is mobilized through an upper midline abdominal incision[14,17] and transposed into the chest through an anterior transdiaphragmatic[14,17,18] or substernal route.[14,17] This aspect has partially limited its clinical preference. Therefore, we applied a transdiaphragmatic harvesting technique of the greater omentum, which avoided an additional abdominal incision and was performed through the usual thoracotomy. Our technique proved safe because there were no complications related to the omentoplasty procedure during the postoperative follow-up. The contraindication for our omentoplasty technique was a previous abdominal intervention.[3] Patients with right side bronchopleural fistula were also not suitable candidates for this technique if significant hepatomegaly was revealed preoperatively on CT scan, as the enlarged liver would limit access to the abdomen.[3]

Conclusion

In conclusion, the transdiaphragmatic harvesting technique of omental flap through a thoracotomy is safe and technically feasible, and surgical treatment for postoperative bronchopleural fistula with omental flap covering is effective.

Disclosure

No authors report any conflict of interest.

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