designed to fit the defect, within the limitations mentioned above. It can be tubed and, because it is an island flap, two end-to-end anastomoses can be made (Fig. 5). The procedure should not be considered a replacement for pharyngolaryngo-oesophagectomy and pharyngogastric anastomosis ('stomach pull-up'), but is rather an alternative to this operation in certain selected patients. So far it would appear to be superior to the multistaged procedures previously described by Wookey and Bakamjian.

The PMMC flap has the disadvantage that the skin used is usually hair-bearing in men. This, however, has not been a major problem in our patients (Fig. 6). The bulkiness of the muscle may be undesirable in certain cases, especially in muscular males; however, the muscle can usually be trimmed to fit the defect, but it should not be smaller than the skin paddle.

The results of using a portion of rib attached to the muscle in one case have been encouraging. The viability of the bone depends on preservation of the periosteal blood supply. More recent experience by myself and others has shown that the PM osteomyocutaneous flap with rib has an unreliable viability. The trapezius osteomyocutaneous flap using spine of scapula is now considered to be the operation of choice for mandibular reconstruction.

I wish to thank Professor D. P. Bryce for allowing me, as his Fellow, to operate on and report on his patients, Dr R. Hayden for referring patients 6, 7 and 8, Dr V. S. Dayal for referring patient 9 and Dr J. M. Fredrickson for referring patient 12.

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The operative management of acute post-pneumonectomy bronchopleural fistula after flush bronchial amputation

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Summary

Acute disruption of the bronchial closure after pneumonectomy causes severe problems in patient management. Radical attempts at closure of the fistula and space obliteration (thoracoplasty) carry a high mortality. The management of this condition by a series of staged operative procedures is described. Pneumonectomy has usually been performed for bronchogenic carcinoma and prognosis is therefore guarded. Several low-risk operative interventions, with discharge from hospital between procedures, provide a safe and effective management method in the case described.


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Acute disruption of the bronchial closure following pneumonectomy is fortunately an uncommon event. It occurs about 10 days postoperatively and infection of the post-pneumonectomy space usually follows. The correction of this grave complication requires initial prompt supportive therapy and a series of planned operative interventions. Because massive post-pneumonectomy bronchopleural fistula is rare, few surgeons have extensive experience in its management. The literature on bronchopleural fistula is large; however, few of these numerous reports have detailed the management of an acute post-pneumonectomy fistula. The timing of surgical intervention and the type of operative procedure advocated vary widely. 7,9,10

During the decade 1965 - 1975, in a series of 100 consecutive pneumonectomies carried out at the New York University Medical Center, 2 massive bronchopleural fistulas occurred postoperatively; both patients were treated by early operative intervention, with closures of the fistula using intercostal muscle flaps. The repair attempts failed and both patients ultimately died. Analysis of these failures caused us to formulate a staged approach which was successfully employed in a subsequent patient. Prompt pleural drainage was initiated and the patient’s clinical condition was stabilized. A group of operative procedures was then used in a sequence that ensured safety and minimal morbidity. Extensive reconstructive and plastic procedures were avoided. The purpose of this article is to detail this means of managing acute massive post-pneumonectomy bronchopleural fistula when there is no long bronchial stump remnant but rather a flush division of the tracheobronchial junction. Division and closure of the main bronchi within 1 cm...
of its origin remains the standard technique employed at the New York University Medical Center for pneumonectomy.1

Management
Initial therapy
The breakdown of the post-pneumonectomy bronchial closure opened a channel between a collection of fluid and the patient's remaining lung. The initial steps were to save the patient from drowning and to prevent further soiling and pulmonary damage. The patient was positioned with the pneumonectomy space down and all remaining fluid was evacuated with an intercostal drain and underwater seal system. This manoeuvre also stabilizes the mediastinum. Intensive physiotherapy and administration of broad-spectrum antibiotics were started to reverse the sequelae of contamination pneumonitis. Pleural fluid was sent for Gram staining and culture. Once the mediastinum was stable (approximately 20 days after pneumonectomy) a rib resection was performed under local anaesthesia to establish wide, dependent drainage of the post-pneumonectomy space. Shortly thereafter the patient was discharged on daily pleural irrigations with an antiseptic solution.

Intermediate therapy
After an interval of 6 weeks the patient was readmitted. Evidence of metastatic disease or of local recurrence of the carcinoma would have precluded further treatment of the bronchopleural fistula. Flexible bronchoscopy and thoracoscopy were carried out under local anaesthesia to assess the appearance of the bronchial stump and the pleural space. Cultures of the pleural secretions and sputa were obtained. Conditions being favourable, closure of the bronchopleural fistula was undertaken.

Anaesthetic induction and management are as important as the operation itself. Arterial pressure monitoring and frequent blood gas determinations were extremely helpful in patient management. Adequate premedication was given and anaesthesia was induced with the patient supine. Auffed endotracheal tube was inserted into the bronchus of the remaining lung.

Once this lung was isolated the patient was turned into the appropriate lateral position. A posterolateral thoracotomy was made over the 6th rib and a careful subperiosteal resection of the 6th rib was carried out. Once the resected rib was removed a composite intercostal flap was formed as shown in Fig. 1. The flap consisted of the 5th and 6th intercostal muscles and the periosteal bed of the 6th rib. The flap was detached from the lower border of the 5th rib above and the upper border of the 7th rib below. Anteriorly it was divided just lateral to the internal mammary vessels. Conditions being favourable, closure of the bronchopleural fistula was undertaken.

Fig. 1. The 6th rib has been removed. The composite flap is seen to consist of the muscles of the 5th intercostal space, the periosteal bed of the 6th rib and the intercostal muscles of the 6th space. The flap is mobilized by detaching it from the inferior surface of the 5th rib and the superior surface of the 7th rib. Anteriorly the flap is divided just lateral to the internal mammary vessels. The intercostal vessels of the 6th space supply the flap.

Fig. 2. The intercostal muscle flap has been developed so that adequate length exists to reach the bronchopleural fistula and to permit it to be turned on itself without jeopardy. The fine stainless steel sutures are single bites on the edges of the defect, but pass through the flap as mattress stitches.

An elective tracheostomy was performed; this ensured that the patient was breathing spontaneously with the tracheostomy tube balloon. The sutures were passed through the intercostal muscle flap as mattress stitches. The flap was gently snugged down and tied. New chest tubes were placed and the thorax was closed using stainless steel wire sutures which passed through the 5th and 7th ribs. The chest wall muscles and subcutaneous tissues were approximated in one layer with O-Dexon interrupted sutures, and the skin was closed with nylon sutures.

An elective tracheostomy was performed; this ensured that the patient could not raise his intratracheal airway pressure by coughing and so stress the flap repair. It also allowed for gentle suctioning of the remaining lung. At the end of the operative procedure the patient was breathing spontaneously with anaesthesia fully reversed. Extubation was carried out at this point. This manoeuvre was critical because a period of positive-
pressure ventilation, should it be necessary, would stress the flap, possibly causing leaks and failure. Similarly, a successful outcome would be unlikely should significant atelectasis occur in the remaining lung. Once this difficult period was over the patient made rapid progress. The tracheostomy tube was removed after 10 days. The patient was then discharged again to manage his tracheostomy tube at home with daily irrigations and dressings.

Final therapy

Twelve weeks after closure of the bronchopleural fistula the patient was re-evaluated. The sputum and pleural secretions were cultured. The pleural space was inspected and was found to be lined by healthy, clean fibrous tissue. Under local anaesthesia the pleural space was filled with a saline and neomycin solution, as originally described by Claggett. The thoracostomy margins were mobilized and the edges excised. Meticulous haemostasis was achieved. The edges were approximated in a single layer using heavy nylon sutures. The patient was discharged within a week of this procedure.

Discussion

Several varieties of post-pneumonectomy bronchopleural fistula have been described. Some are small and evidenced only by intermittent productive cough and patchy pneumonitis of the remaining lung with some decrease in the amount of fluid in the post-pneumonectomy space. The conservative management of these fistulas should include early tube drainage of all remaining fluid before embarking upon bronchoscopy and intrapleural methylene blue injection or other diagnostic measures. The protection of the remaining lung must receive priority once the diagnosis of bronchopleural fistula is suspected. Bronchopleural fistulas of small to moderate size will close after flush bronchial amputation offers no substantial bronchial remnant on which to base repair. An intercostal muscle flap accurately sutured to the margins of the defect under the delayed, controlled conditions detailed in this article (i.e. minimal postoperative positive-pressure ventilation is required and a tracheostomy is used to prevent elevation of intratracheal pressure) offers a safe and effective method of closure. Two of the three operative interventions are carried out under local anaesthesia, which minimizes stress. It should not be forgotten that in most cases pneumonectomy has been performed for malignant disease and that prognosis in these patients is therefore uncertain. Major procedures such as hemithoracic thoracoplasty are contraindicated for this reason. The efficacy of the Claggett procedure has been confirmed with the passage of time. Extensive operative procedures using chest wall muscles to help obliterate post-pneumonectomy spaces are no longer indicated.

The success of the Claggett procedure or modifications of it, reported by authors with large series of patients with post-pneumonectomy empyema spaces, clearly indicates its superiority in the handling of post-pneumonectomy infective spaces with or without associated bronchopleural fistula. The trend in the thoracic surgery literature is away from extensive, mutilating thoracoplasty procedures for the handling of intrapleural spaces.

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