

Modified thoraco-mediastinal plication (Andrews thoracoplasty) for post-pneumonectomy empyema: experience with 30 consecutive cases[†]

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Abstract

OBJECTIVES: The aim of our study is to evaluate the results of thoraco-mediastinal plication for the treatment of post-pneumonectomy empyema.

METHODS: From 1 January 1985 to 1 January 2011, 30 patients underwent post-pneumonectomy empyema through a modified thoraco-mediastinal plication procedure (Andrews thoracoplasty). Indications for pneumonectomy included cancer (25 cases), tuberculosis (3 cases), and bronchiectasis (two cases). Rib resection was performed according to the topography of the cavity, ranging between 5 and 10. Neighbourhood muscle flaps were used in 22 cases but extensive mobilization was performed only in our last 4 cases, the aim of the procedure being the complete obliteration of the infected space. Bronchial fistula was present in 14 cases and was closed and reinforced with the use of flaps (intercostal 12 cases, serratus 1 case, and omentum 1 case).

RESULTS: Overall mortality was 6.7% (2 cases); 2 patients (6.7%) presented with recurrence of the empyema requiring an open-window procedure and another patient (3.3%) presented with local tumoral recurrence. Intensive care unit hospitalization ranged between 1 and 14 days, with a median of 4 days, while overall postoperative hospitalization ranged between 23 and 52 days with a median of 32 days, the patients being discharged with healed wounds. Kaplan–Meier analysis of the oncologic patients showed a median survival of 41 months from thoraco-mediastinal plication. The presence of bronchial fistula had no statistically significant impact on the immediate outcome (mortality, need for postoperative prolonged mechanical ventilation, intensive care and overall postoperative hospitalization, $P > 0.05$ for all the parameters).

CONCLUSIONS: Space-filling procedures are a valuable option for treating post-pneumonectomy empyema. The major advantages are the complete obliteration of the infected space and the quick healing from a single procedure; the major disadvantages are the magnitude of the procedure (with associated mortality and morbidity) and the permanent chest mutilation. Several technical details may improve the results and reduce the chest wall mutilation.

Keywords: Post-pneumonectomy empyema • Thoracomyoplasty • Bronchial fistula

INTRODUCTION

Despite some promising new prophylactic methods [1], post-pneumonectomy empyema remains a very serious complication in modern thoracic surgery which cannot be completely avoided [2]. There is no standardized treatment, and it seems that we are far from establishing a gold standard. Many solutions have been described, each with advantages and disadvantages [3]. In this article, we report the results achieved with the use of a thoraco-mediastinal plication procedure (with several technical modifications to the classic thoracoplasty procedure described by Andrews [4]).

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MATERIALS AND METHODS

Patients

This is a retrospective study performed over a 26-year period (1 January 1985 to 1 January 2011). During this period, we have treated 30 patients in our unit with post-pneumonectomy empyema through a modified thoraco-mediastinal plication procedure. Indications for the initial pneumonectomy included cancer (25 cases), tuberculosis (three cases) and bronchiectasis (two cases). Nine cases were referred to our unit from other centres.

The interval between pneumonectomy and thoraco-mediastinal plication ranged between 4 weeks and 4 years. In 3 cases with suppurative destroyed lung and empyema, the

thoraco-mediastinal plication was performed at the time of pneumonectomy (all of them operated on at the beginning of our experience, this strategy now having been abandoned). All patients received antibiotics according to the sensitivity of the involved micro-organisms.

Operative technique

Our technique includes several modifications to the original thoraco-mediastinal plication/thoracoplasty procedure described by Andrews in the 1960s [4]. Access to the cavity was achieved through a postero-lateral incision. After opening the empyema cavity, this was debrided and cleaned. Rib resection was performed according to the topography of the cavity, ranging between 5 and 10 (Fig. 1A). The parietal pleura was carefully cleaned by curettage but not completely excised; careful debridement and repeated lavage of the cavity were performed, with the aim of removing the diseased tissue (Fig. 1B). By vertical incisions combined with incisions through the bed of the resected ribs, we created intercostal flaps (containing the parietal pleura, the periosteum and the intercostal space, including the muscles) which were used for closure-reinforcement of the bronchial fistula and plumbage of cul-de-sacs (Fig. 1C). We did not suture the remaining pleuro-periosto-intercostal plane to the mediastinal pleura as described in the original technique developed by Andrews [4]. Fixation of the chest wall to the mediastinum was achieved by external compression. In the remaining cavity, we placed an irrigation-aspiration system consisting of one to two normal chest drains placed in the inferior part of the cavity and connected to a standard drainage system and a small tube connected to a perfusion set (Fig. 1D). This system allows postoperative lavage with disinfectant and antibiotic solutions [5].

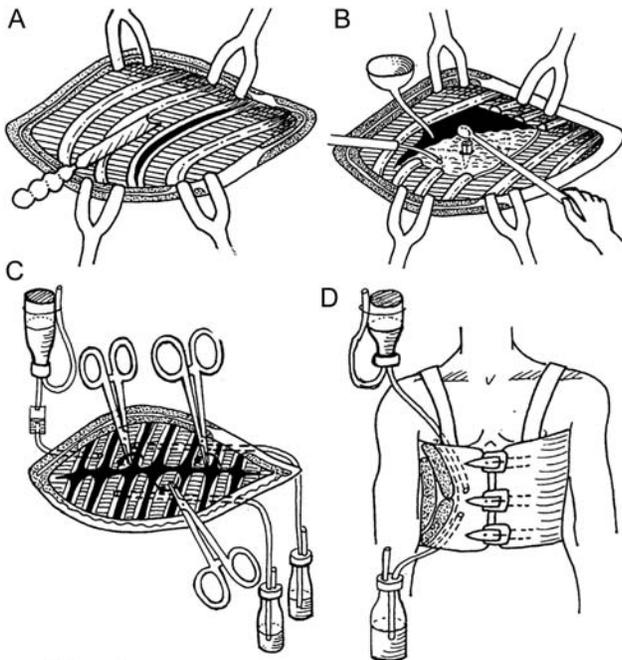


Figure 1: Main operative steps of the thoraco-mediastinal plication technique used in our unit (for details see Materials and Methods section).

Neighbourhood muscle flaps were used in 22 cases but extensive mobilization, including the previously sectioned muscles [6, 7], was performed only in our last 4 cases, the aim of the procedure being the complete obliteration of the infected space (Fig. 2).

Bronchial fistula was present in 14 cases and was closed and reinforced with the use of flaps: intercostal (12 cases), serratus (1 case), and omentum (1 case).

Statistical analysis

Data were collected from our unit's database using Microsoft Excel tables; for the statistical analysis, we used GraphPad Prism 4 for Windows software (GraphPad Software, San Diego, CA, USA). Mortality, morbidity, incidence of local complications, hospitalization and quality of life were evaluated for the whole group, with no supplementary sub-grouping considering the small number of patients. Kaplan-Meier survival was evaluated only for oncologic patients. A separate comparative analysis was performed according to the presence or absence of the bronchial fistula. Comparison between groups was performed with Fisher's exact test and the Mann-Whitney test, as appropriate; a P -value < 0.05 was considered to be statistically significant. Quality of life was evaluated by calculating the Karnofsky index and late survival (from the time of thoraco-mediastinal plication) was evaluated by the Kaplan-Meier method.

RESULTS

Mortality

Overall mortality was 6.7% (two patients). The causes of death were pneumonia with respiratory failure and heart failure. In both cases, death occurred in the first week postoperatively, which seems to be critical for these patients.

Morbidity

Overall, we encountered 18 major complications, defined as situations with life-endangering potential requiring immediate treatment. Most of these complications occurred in the first postoperative days. Details of these complications are presented in Table 1.

Local complications

Two patients (6.7%) presented recurrence of the empyema which was solved by a modified open window consisting in reopening of the wound and soft tissues (no supplementary rib resection). Another patient presented local tumoral recurrence with invasion of the remaining chest wall. In this series of patients, we encountered no reoperation for haemostasis. At the beginning of our experience, we used injection of contrast in the intracavitary drains to follow-up the obliteration of the empyema, but this method was replaced by CT scan, which offers more detailed information about the residual cavities, viability of the flaps and overall chest deformity (Fig. 3).

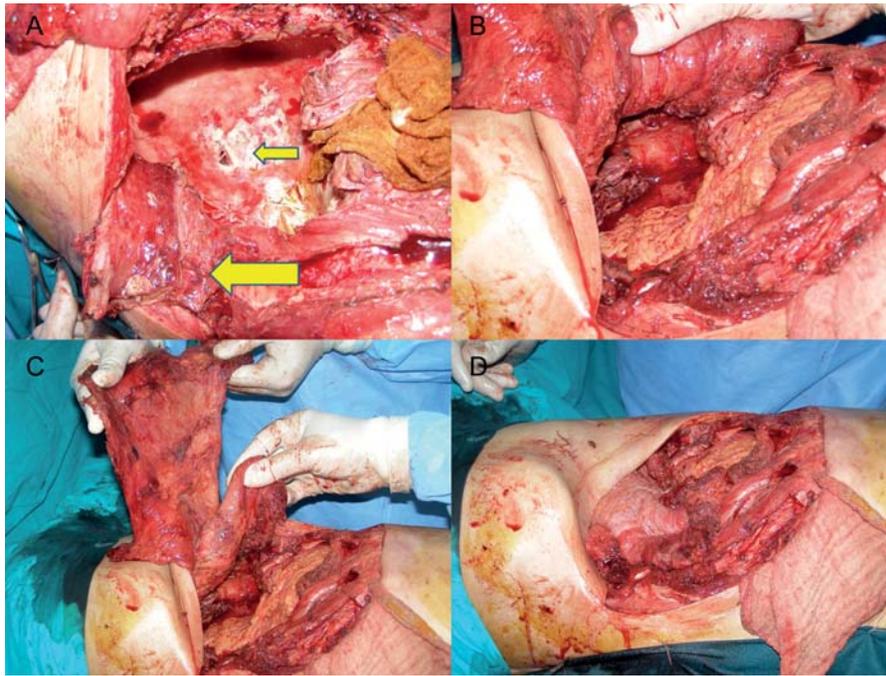


Figure 2: Intraoperative images from one of the last cases. (A): aspect of the cavity after rib removal and debridement. The small arrow indicates a large right bronchial fistula and the big arrow indicates an intercostal flap with posterior blood supply. (B): Trans-diaphragmatic mobilization of an omental flap for a patch closure of the bronchial fistula. (C): Extensive mobilization of the latissimus dorsi and serratus anterior muscles. (D): Final aspect before closure of the skin and subcutaneous fat, showing complete obliteration of the space.

Table 1: Major general complications encountered after thoraco-mediastinal plication for post-pneumonectomy empyema

Complications	No of cases/ incidence
Respiratory failure, mechanical ventilation >12 h after surgery	4 (13.3%)
Heart failure, need for major inotropic support	5 (16.6%)
Renal failure, haemofiltration	1 (3.3%)
Hepatic dysfunction	5 (16.6%)
Upper digestive bleeding, conservative treatment	3 (10%)

Hospitalization

Intensive care unit hospitalization ranged between 1 and 14 days, with a median of 4 days; in all cases, the patients were transferred from the intensive care unit with stable cardiorespiratory status and no major complications.

Overall postoperative hospitalization of the surviving patients ranged between 23 and 52 days with a median of 32 days. All patients were discharged with healed wounds and no need for further surgical care.

Quality of life

We were able to evaluate the status of 25 of the survivors at 1 year after surgery. Twenty-three of them had an active life with no need for assistance with current activities, corresponding to a Karnofsky index over 70. A significant impairment of shoulder

mobility was encountered in 5 patients (16.6%), but which did not interfere with daily activities.

Late survival

Kaplan-Meier analysis of the oncologic patients (initial pneumonectomy performed for lung cancer) showed a median survival of 41 months from the time of thoraco-mediastinal plication. During this period, the overall standardization of the management of patients with lung cancer underwent several major changes, making detailed analysis of these data difficult; however, we believe that this survival is a serious argument for not abandoning these patients.

The impact of the bronchial fistula

Although bronchial fistula was present in 14 patients, its presence had no statistically significant impact on the immediate outcome after this procedure. When comparing the fistula (14 patients) vs no fistula (16 patients) groups, we found no statistically significant difference in terms of:

- (i) mortality (1/14 vs 1/16, Fisher's exact test $P=1.000$, OR = 1.154, RR = 1.077);
- (ii) need for prolonged postoperative mechanical ventilation (1/14 vs 3/16, Fisher's exact test $P=0.601$, OR = 0.333, RR = 0.500);
- (iii) ICU hospitalization (fistula, range 1-14, median 3 days vs no fistula: range 2-8, median 4 days, Mann-Whitney test: $P=0.6618$);

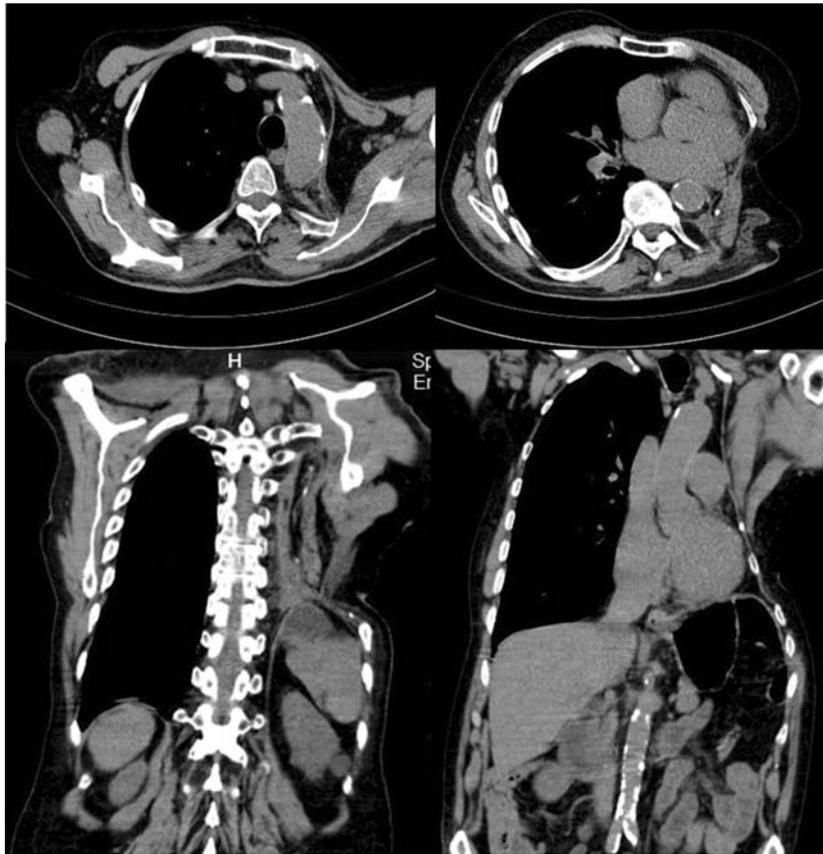


Figure 3: CT aspect at 10 years after a modified thoraco-mediastinal plication (Andrews thoracoplasty) performed for a left post-pneumonectomy empyema (no extensive muscle flap mobilization). There is no residual space and an obvious but acceptable thoracic deformity.

(iv) overall postoperative hospitalization (fistula: range 23–52, median 32 days vs no fistula, range 30–42, median 4 days, Mann–Whitney test: $P = 0.6618$).

DISCUSSION

Post-pneumonectomy empyema remains an entity for which we do not have a standardized treatment. In a recently published best evidence topic, Zahid *et al.* [3] analyse the literature and conclude that the open approaches using major surgery offer better results compared to the minimally invasive methods. However, analysis of the available published literature shows that a true evidence-based approach [8] to this problem is very difficult:

- (i) The number of patients is very small; most large series are based on a few dozen patients, with no published study including more than 100 patients coming from the same centre; our own study is also made on a relatively small number of patients, with 1–2 patients operated on each year, making this a rarely performed procedure.
- (ii) There are no studies making a direct comparison between two methods, with different teams achieving different results with the same procedure.
- (iii) The published series are very heterogeneous in terms of presence or absence of the bronchial fistula, status of the patients, time from pneumonectomy etc., which makes a fair comparison of the results achieved by different authors almost impossible.

(iv) The advantages and disadvantages of some procedures are very difficult to put in balance, i.e. open window is a very easy procedure but leaves a large open wound that needs a few months (or even more) to heal; thoracoplasty has a high rate of definitive closure but involves a major procedure and significant chest mutilation.

Owing to the small number of patients and their great heterogeneity, it is obvious that we cannot talk about any kind of prospective randomized studies. It is also obvious that personal preference plays an important role in the overall management of these patients. During the last years, some new techniques and strategies have been proposed, with the main aims of reducing the magnitude of surgery through a less invasive approach [9, 10], including thoracoscopy and VATS [11, 12] and accelerating healing [13, 14]. Despite some excellent published results, these new techniques have not become popular and are used only in very few centres.

The principles of the procedure were respected in all cases (as detailed above) but the extent of rib resection and the use of flaps was not standardized; a major aspect of this kind of procedure is to adapt the technique to the local anatomy of each patient, which is quite heterogeneous (dimension and location of the empyema, cul-de-sacs and dead angles, bronchial fistula, etc.). This makes a fair statistical analysis very difficult and explains why we focussed on parameters that are usually used to evaluate a major thoracic procedure.

Bronchial fistula deserves special consideration because its closure is mandatory, no matter what treatment is used for this

condition. We performed a comparative evaluation of the patients with vs without bronchial fistula, because the presence of a bronchial fistula is usually associated with a higher mortality [15]. At the beginning of our experience, we used only intercostal flaps, but after we started to perform extensive mobilization of the neighbourhood flaps, we also used them for closure of the bronchial fistula. We believe that the flap by itself is less important as long as it remains well vascularized at the end of the procedure. Suture-reinforcement with well-vascularized tissue appears to be a simple and safe option. Our statistical analysis showed that the presence of the bronchial fistula had no impact on the postoperative results. This may be explained by the fact that the bronchial fistula is a major risk factor for complications in the acute phase of the treatment, when there is a major risk for contralateral lung over-perfusion. If the patient survives this phase, the bronchial fistula can be safely closed with a low risk of recurrence and no possibility of further contralateral bronchial over-perfusion.

The time required for complete healing is also important since, the indication for pneumonectomy is lung cancer, so that many of them require postoperative chemotherapy or radiotherapy. As many oncologists are reluctant to start the adjuvant therapy in the presence of an empyema, rapid healing is an important advantage of this kind of procedure; this seems to be a major advantage of surgical approaches based on thoracoplasty [16]. Considering the gravity of this medical situation, we believe that the mutilation of the chest is reasonable.

We also believe that the modifications used by us may offer several advantages compared to the original technique described by Andrews in 1960s [4]:

- (i) Abandoning the mattressing of the remaining chest wall to the mediastinal pleura by 'U' stitches avoids the lesions to the mediastinal structures, reduces the ischaemia of the remaining chest wall resulting from tightening the stitches and allows a final fixation in a more physiological position.
- (ii) Sectioning of the remaining pleura-periosteum-intercostal plane allows the creation of intercostal flaps for bronchial fistula closure, filling of dead angles and cul-de-sacs; these flaps can be created according to the topography of the lesion for each particular patient.
- (iii) The irrigation-aspiration system allows a certain control of the cavity in the early postoperative period.
- (iv) The extensive mobilization of the neighbourhood muscle flaps allows filling of the cavity with well-vascularized tissue and reduces the need for rib resection.

However, these advantages are based on intraoperative findings and common-sense judgement; they are difficult to prove statistically considering the small number of patients and the great heterogeneity of the local anatomy which makes comparative studies very difficult, even in multi-centre trials.

CONCLUSIONS

Modified thoraco-mediastinal plication (Andrews thoracoplasty) remains a valuable option for post-pneumonectomy empyema. It achieves complete and definitive obliteration of the space and quick healing through a relatively simple procedure. Different technical details (no mattressing of the remaining chest wall to the mediastinal pleura with external compression allowing a more physiological definitive fixation of the chest structures,

postoperative irrigation-aspiration, safe closure of the bronchial fistula, extensive mobilization of the available neighbourhood muscle flaps) may increase the adaptability of the procedure to the local anatomy, improve the outcome and reduce the chest wall mutilation compared to the classic thoracoplasty techniques.

Conflict of interest: none declared.

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APPENDIX

CONFERENCE DISCUSSION

Dr M. Jimenez (Salamanca, Spain): Post-pneumonectomy empyemas are some of the more difficult and vexing problems in thoracic surgery. Most of them we treated with evacuation, as you said, and debridement, and then we needed to open the cavity and treat it with systemic antibiotics. This was the treatment of choice during the last century. But, as you pointed out, in one of

the largest series of post-pneumonectomy empyema from two different countries and two different hospitals, 75 consecutive patients were treated with repeated open surgical debridement until the pleural cavity was finally filled with antibiotics and then definitively closed.

My experience is similar to Dr Schneider and colleagues. After reading his paper and facing a case of a young nurse with a post-pneumonectomy empyema, we treated this patient using this accelerated treatment and it worked, and then we decided to use this method as the treatment of choice for post-pneumonectomy empyema.

I have two questions for you. My first question is, you concluded in your presentation that the patients you treated had a good quality of life and satisfactory cosmetic result; could you explain how you measured this result?

Secondly, in 2004 at the Chest meeting you presented 26 cases treated with this method and in the last seven years you have done four more cases.

Dr Botianu: Yes.

Dr Jimenez: Comparing the experience from Schneider and colleagues and your results, do you still recommend the thoraco-mediastinal plication as the treatment of choice for postpneumonectomy empyema?

Dr Botianu: Starting with the second question, I think that the method proposed by Schneider and Grodzki is a good option for early post-pneumonectomy empyema when you detect a problem from the beginning and there is not such a big contamination of the post-pneumonectomy space and the tissues are not so infiltrated, and, of course, there has to be no bronchial fistula or, if there is some bronchial fistula, it should be in some way closed by surgery or by an endoscopic method. It is difficult to recommend one or the other solution. As I said, each of them has some advantages and some disadvantages. Again, I think that the method proposed by Schneider is a good option for early post-pneumonectomy empyema, but I think our experience with the open window in late cases, after there has been a massive contamination of the space, was not so good. And it is true, this seems to be a quite large series, 30 patients, but this experience was achieved over 26 years, so it's around one patient a year.

Dr Jimenez: And the first question?

Dr Botianu: Could you repeat it? I did not understand it.

Dr Jimenez: How did you measure the quality of life?

Dr Botianu: Basically we used the Karnofsky index. If this is over 70, we consider that the patient has an acceptable quality of life. Practically all of the patients returned to normal; they went home alone; they required no special assistance. Of course, they could not go and perform extensive physical work, but they could stay at home and do their daily activities without any problem.

Dr S. Margaritora (Rome, Italy): How long do the patients wear this external contention?

Dr Botianu: Between 2 and 3 weeks.

eComment. Hybrid conservative approach in the treatment of post-pneumonectomy bronchopleural fistula

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We have read with great interest the article by Botianu and Botianu concerning Andrews thoracoplasty for post-pneumonectomy empyema and we have to congratulate them on their results [1].

The aim of our brief comment is to highlight the importance of the hybrid approach, especially in cases of small-sized (<5 mm), early post-pneumonectomy bronchopleural fistulae. In such cases endoscopic application of fibrin sealants combined with pleural drainage tube could solve the problem. If no improvement is observed, the endoscopic procedure can be repeated. Surgery seems to be the gold standard in cases with complete dehiscence of the suture or extensive endobronchial infection and fibrin around the edges [2]. Surgery is also indicated when endoscopic treatment fails. However, endoscopic interventions are safe and free from severe complications and could be the first therapeutic approach.

Conflict of interest: none declared

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