Residual apical space following surgery for pneumothorax increases the risk of recurrence

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Abstract

Objective: Residual air spaces on chest radiographs after pneumothorax surgery are not uncommon. We aimed to study their incidence and impact on surgical outcomes.

Methods: Four hundred and twenty-seven patients (283 men and 144 women with a median age of 31 (14–96) years) underwent surgery for pneumothorax from 1995 to 2005 in a single unit. Video-assisted thoracoscopy was used in 225 cases (53%). Outcomes were: duration of intercostal drainage and hospital stay, recurrence, re-operation and referral to chronic pain clinic.

Results: Median duration of intercostal drainage and hospital stay were 5 and 6 days, respectively. We found a recurrence rate of 6.6% (n = 28), re-operation rate of 2.8% (n = 12) and need for referral to pain clinic of 7% (n = 30). In 129 patients (30%) a small residual apical space (RAS) was reported on chest radiograph prior to discharge. Hospital stay and duration of drainage were longer in these cases (p = 0.002 and 0.02, respectively). On multivariate analysis RAS on chest radiograph was associated with increased risk of recurrence [hazard ratio 3.1 (1.4–6.8 95% CI)] (p = 0.005); but no need for re-operation or referral to pain clinic. Re-operation was associated with VATS surgery (p = 0.001) and when no abnormalities were identified at operation (p = 0.04). Referral to pain clinic was more common after open surgery (p = 0.01).

Discussion: The risk of recurrence after pneumothorax surgery is low. But the presence of a residual apical space on chest radiograph after surgery increases it significantly. Recurrence may be due to the failure to achieve early pleural symphysis.

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1. Introduction

Surgery for pneumothorax is indicated for second ipsilateral pneumothorax, first contralateral pneumothorax, bilateral spontaneous pneumothorax, persistent air-leak (>5–7 days), infection, spontaneous haemothorax and professions at risk, e.g. pilots [1]. In performing a surgical procedure for pneumothorax there are two main objectives: to identify and ablate the source of any air-leak and to achieve pleural symphysis in order to minimise recurrence of the pneumothorax.

Our hypothesis is based on the presumption that a failure to achieve early pleural symphysis may correlate directly with recurrent pneumothorax, both early and late. This is based on our own anecdotal clinical experience and published literature. An association between failure of early pleural symphysis and late recurrence has been postulated previously suggesting that recurrence may be due to the absence of formation of pleural adhesions. This was based on the operative findings of those who underwent surgery for late recurrent pneumothorax after previously undergoing a pleural procedure [2].

Currently the only widely available method of determining whether pleural symphysis has occurred is by the absence or presence of a residual apical space (RAS) on chest radiograph post procedure. If there is no residual space, adhesions and symphysis may or may not develop; in contrast if there is a space then symphysis cannot occur. Therefore the aims of this study were to identify the incidence of RAS on chest radiograph post pneumothorax surgery, and to determine the implications of this RAS on long-term outcomes including recurrence, re-operation and the need for referral to the chronic pain clinic.

2. Patients and methods

2.1. Data collection

All patients who underwent surgery for pneumothorax in our unit between 1995 and 2005 were identified from the prospective clinical audit database. Additional information
was then collected retrospectively from medical notes and from the computerised radiology reporting system in all patients.

This data included basic demographic information, a description of the type and site of surgery undertaken, information regarding postoperative care and a number of outcome measures including duration of intercostal chest drainage, hospital stay, recurrence, re-operation and referral to the chronic pain clinic.

2.2. Patients

We identified a total of 427 patients who underwent unilateral surgery for pneumothorax in our unit between 1995 and 2005. This comprised of 283 males and 144 females, with a median age of 31 (range of 14—96) years. Sixty-eight percent of patients were treated for primary (no previous lung pathology) and 32% for secondary pneumothoraces (in the context of lung disease, mainly emphysema). One hundred and sixty-eight patients (39%) were current smokers at the time of surgery and a further 65 (15%) were past smokers. Indications for surgery included: recurrence (61%), persistence (35%) and tension pneumothorax (3.3%). Admission for surgery was elective in 213 (50%) patients and inpatient transfer from respiratory units in our region in 214 patients. Of these, 189 came to the operating theatre with an intercostal drain in place. We do not routinely assess patients with primary spontaneous pneumothorax with a CT scan. Demographic and surgical data are presented in Table 1.

2.3. Surgical and postoperative data

Surgery was performed by VATS in 225 (53%) and open surgery in 202 (47%) cases. Most patients in the earlier years underwent open procedures while VATS is currently the standard method for treatment. The main surgeon was of consultant level on 174 (41%) and a trainee in 253 (59%) cases. At operation lung lesions were identified in 362 (85%) cases (bullae were seen in 49% and subpleural blebs in 36% of cases). Therefore no lesion was identified in 65 (15%) cases and in the absence of any macroscopic abnormality the standard practice was to perform a wedge resection of the apex of the lung in the majority of cases (98%).

Subtotal apical parietal pleurectomy was the pleural procedure of choice and was performed in 363 (85%) cases. The remainder of patients underwent pleurodesis with sterile talc (9%) or mechanical pleural abrasion (6%). The procedure was chosen at the discretion of the surgeon taking into account the individual patient’s circumstances. In the majority of patients (94%) two intercostal drains were placed at the end of the procedure.

Routine removal of the intercostal drains was carried out when no air-leak was demonstrated on coughing, when drainage was less than 150 mls/24 h, and the lung appeared completely expanded on chest radiograph.

A thoracic epidural was used as a postoperative analgesia in 367 patients (86%). Twenty-three percent of patients were discharged home on oral opioids. In 174 patients (41%) non-steroidal anti-inflammatory drugs (NSAD) were used at some point during their hospital stay, either as part of patients’ own medication for other pathologies or prescribed post-operatively.

2.4. End points

We defined RAS as a radiologically detectable space between chest wall and apex of lung determined by the radiologists’ report of the final chest radiograph prior to patient’s discharge and once all intercostal drains had been removed. In the vast majority of cases it represented a small apical space (Fig. 1a) or a minimal rim of air in the pleural space (Fig. 1b).

We do not employ lateral radiographs or CT scan routinely, and the definition applies to findings on either antero-posterior or postero-anterior projections.

Recurrence of pneumothorax in the short- and long-term was identified from further correspondence from the patient, their general practitioner, a referring physician or surgical colleague in another region of the country. Due to the geographical area covered by our thoracic surgery unit it is unlikely that a patient sustained a further pneumothorax and was not brought to the attention of the unit or the unit would...
not have received documentation of further episodes. Re-operation includes surgical procedures, and not insertion of intercostal drains or thoracocentesis. Chronic pain was defined as patients with persisting pain necessitating referral to the chronic pain clinic.

2.5. Statistical analysis

The data are presented as median (range) and number (percentage) unless otherwise stated. Univariate analysis was performed using the $\chi^2$ test for qualitative and Mann–Whitney U test for quantitative data. Variables considered significant to the level of a $p$ value $<0.1$ on univariate analysis were subject to multivariate, forward, stepwise, binary logistic regression analysis to determine their weight as predictor of outcomes. Statistical significance was defined by $p$ values $<0.05$ throughout the study.

3. Results

There were no operative deaths in this group of patients. The median duration of postoperative intercostal chest drainage was 5 (range 1–51) days and the median postoperative hospital stay was 6 (range 2–64) days.

3.1. Incidence and consequences of residual apical space

One hundred and twenty-nine (30%) patients had reported small RAS on their chest radiographs prior to discharge from hospital. On univariate analysis, we found no significant difference in the incidence of residual apical space in those who had undergone surgery for a primary or secondary pneumothoraces, those who had undergone VATS or open surgery nor whether a trainee or consultant performed the procedure.

RAS was however associated with longer duration of intercostal chest drainage of 5 days versus 4 days in those with no residual apical space ($p = 0.02$) and also with a longer hospital stay of 7 days versus 6 days ($p = 0.004$).

3.2. Recurrence of pneumothorax

To our knowledge, at the time of analysis, 28 patients (6.6%) developed a subsequent recurrent pneumothorax.

RAS was associated with an increased risk of recurrence on univariate analysis ($p = 0.01$). Other variables such as surgical approach (VATS vs open), no lung pathology found and the use of non-steroidal drugs were entered on a multivariate analysis. Of them, only the presence of a RAS was associated with recurrent pneumothorax 11.6% versus 4.4%, with a hazard ratio (HR) of 3.1 (1.4–6.8 95%CI), $p = 0.005$ (Table 2).

3.3. Re-operation for recurrence

Re-operation for recurrent pneumothorax was required in 12 patients (2.8%), 3 for early and 9 for late recurrence. The remaining cases of recurrence were managed either by observation ($n = 11$) or by insertion of intercostal drain with or without talc poudrage via drain ($n = 5$). Seven additional patients required surgical intervention in the postoperative period for haemorrhage/removal of haematoma ($n = 5$), persistent air-leak ($n = 1$) or empyema ($n = 1$).

VATS surgery, RAS, experience level of primary surgeon, absence of lung pathology, and primary/secondary pneumothorax were entered on multivariate analysis. On this multivariate analysis, the total number of re-operations performed is associated with VATS surgery. Re-operation was performed in 5.7% of cases ($n = 12$) versus none (0%) after open surgery, $p < 0.001$.

The incidence of re-operation is also higher when no intra-operative abnormality of the lung is detected 8.1% ($n = 5$) than when either bullae or blebs are found 2% ($n = 7$) [hazard ratio 4.3 (1.1–17.1 95%CI), $p = 0.04$]. RAS was not associated with re-operation ($p = 0.1$) (Table 2).

3.4. Referral to pain clinic

Formal referral to chronic pain clinic was made in 30 cases (7%). On multivariate analysis, referral was more frequent after open surgery compared with VATS, 9.9% versus 4.4% [HR 4.5 (1.5–13.1 95% CI), $p = 0.01$] and in patients who were discharged home with an intercostal drain attached to a flutter-valve system 22.7% versus 6.2% [HR 2.8 (1.2–6.6 95% CI), $p = 0.01$] (Table 2).

4. Discussion

The most common indication for surgery in our patient cohort was recurrence in over 60% of cases. This correlates well with data in the literature [3]. In 15% of cases a pulmonary abnormality could not be identified during...
surgery. It is in this group of patients that recurrence has been shown to be greater in previous reports, to the point of suggesting that apical wedge resection should be performed even in the absence of obvious blebs [4].

Our reported recurrence rate of 6.6% seems to be within the published range of 2–10% [3,5–8]. Indeed, our series include patients undergoing surgery for secondary pneumothorax in which the chances for recurrence appear to be greater [2,8].

The incidence of RAS may look very high in our series. We do not imply that 30% of our patients had a significant pneumothorax after surgery, but that complete apical lung to chest wall apposition may not have occurred. In the vast majority of cases the report refers to a small area in the apex without lung markings as shown in Fig. 1a. We have encountered difficulties finding data in the published literature about this finding following surgery for pneumothorax. After chest tube removal the estimated incidence of pneumothorax is reported between 7% and 23% [9–11] and only around a quarter of them will require active treatment [12]. In some surgical series, however, the presence of residual pleural spaces on chest radiographs not necessitating intercostal drainage can be as high as 15% after lobectomy/decortication [13] and 20% after bilobectomy [14]. We also know that small pneumothoraces can be missed in chest radiographs and a computer tomography could detect twice as many in the context of a percutaneous lung biopsy [15] or blunt trauma [16].

Secondary pneumothorax [8], failure to identify pulmonary lesions [3], and VATS [6] all have been reported to increase recurrence following surgery for pneumothorax. On a multivariate analysis the only factor in our series that independently influenced recurrence was the presence of a RAS.

We preferentially performed pleurectomy as the procedure of choice in spontaneous pneumothorax. A series comparing needlescopic VATS pleurectomy with pleural abrasion found none of the pleurectomy patients had developed a recurrent pneumothorax compared with three in the abrasion group (8.6%) [17]. A further study comparing pleurectomy and pleural abrasion reported that recurrent pneumothorax occurred solely in the pleural abrasion group and most frequently when no lung lesion was identified at operation [5].

In our data series we identified a relationship between intra-operative identification of lung abnormalities and late outcomes. In 15% of cases no potential source of air-leak was detected at surgery. The association of recurrence and failure to identify a lung lesion intra-operatively has been well documented [3,4].

The use of VATS also increased the risk of re-operation in our series (5.7% vs none after open surgery). It seems that recurrence after open surgery was treated by observation/intercostal drainage whereas complications following VATS were more likely to be treated with re-intervention. Cardillo et al. proposed that redo VATS is a viable alternative to open thoracotomy in patients who have a recurrent pneumothorax of greater than 10% [18].

A randomised controlled trial comparing VATS to open thoracotomy for primary spontaneous pneumothorax confirmed that postoperative analgesia requirements and hospital stay were reduced in the VATS group [19]. We identified open surgery as a predictor of needing specialist input for pain control after pneumothorax surgery. The incidence of chronic pain in VATS surgery for pneumothorax in one follow-up study suggested that 31% of patients had some form of chronic pain after a median of 59 months follow up. Though only 2 of the 60 patients followed up required daily analgesia, more in keeping with our chosen outcome, 7% were referred to a pain specialist [20].

Further studies of patients undergoing VATS procedures for a number of benign conditions showed that after 24 months 96% were asymptomatic [21]. In contrast another retrospective analysis shows an overall chronic pain rate of 20% although assessed by a phone questionnaire 2 months after surgery [22]. The use of epidural analgesia has not been shown to improve immediate outcomes after VATS pleurectomy for primary spontaneous pneumothorax [23] and in our series it did not influence long-term outcomes either.

We undertook a literature search in an attempt to identify alternative diagnostic tools which may help to determine the success or otherwise of pleural procedures in achieving early pleural symphysis. We were only able to identify two diagnostic tools. Firstly chest ultrasonography has been suggested as a useful non-invasive method of identifying areas of pleuredesis. A case series of 10 patients has been described. Several patients underwent pleurectomy which was felt to lead to excellent pleuredesis in all cases and abrasion which led to excellent pleuredesis in only one case. One late recurrence occurred in the abrasion group [24]. A second study hypothesised that intrapleural CRP may quantify postoperative pleural inflammation and hence pleural adhesion. They found that in a series of 75 patients who underwent VATS pleurectomy or abrasion in those cases where pleuredesis failed, the peak postoperative CRP level was lower and delayed compared with those where pleuredesis was deemed to be achieved [25]. The clinical implications and possible applications of these methods to everyday practice are yet to be determined.

We acknowledge some limitations of our study. It is the result of a retrospective analysis, and it includes a large time period in which surgical practice has evolved (increased use of VATS). Determining outcomes such as recurrence rates will always remain controversial, however we feel confident that it is extremely unlikely that a patient developed a recurrent pneumothorax of whom we are unaware. This is due to the close ties with referring chest physicians in district general hospitals and the fact that geographically the patients would have to travel long distances to the next nearest tertiary referral centre.

Defining the incidence and impact of pain after surgery is always difficult due to the subjective nature of the symptom and of its treatment, so we elected to define an outcome that could be monitored: a visit to the pain specialist. Residual apical space was determined by an independent third party (a radiologist); therefore they were blinded to the procedure performed. In addition to this we are aware that, as many centres did, our units’ surgical practice altered substantially throughout the time period of this study with a now nearly universal use of VATS.

In summary, we encountered small apical spaces in nearly one third of the patients being discharged after surgery for
pneumothorax. Yet despite this only a small number of patients go on to develop a recurrent pneumothorax. We have shown that the presence of RAS is associated with an increased risk of recurrent pneumothorax although not of requiring re-operation. Although we cannot prove the pathophysiological rationale of the recurrence, we recommend increased efforts to avoid postoperative spaces in order to achieve early lung–chest wall apposition to obtain symphysis.

Our review has instigated two changes in our practice. We now perform closure of the intercostal space after VATS and the drains are tunnelled under the skin and chest wall muscles to enter a fresh intercostal space in an attempt to reduce air spaces after removal of drains. In addition, we pay more attention to small air spaces in the chest radiographs prior to any decision: stopping suction, change into a portable system, removal of drains.

References


