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Original Article

Autologous blood patching in the management of broncho-pleural fistula in spontaneous pneumothorax

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Abstract

Introduction: Autologous blood patching (ABP) has been described as a modality of treatment of bronchopleural fistulas (BPF). The success rates have varied chiefly because the numbers studied have been small and the populations inhomogeneous. We conducted this study to determine the success rate in patients with BPF of spontaneous onset.

Methods: All patients with spontaneous pneumothorax with no evidence of pleural infection and in whom the air leak did not subside despite 48 hours of conservative management were includedThese patients underwent one to three episodes of blood patching in 50ml aliquots. Demographic profile, smoking status, success rate and complications were recorded and compared.

Results: Between July 2011 and January 2014, seventy-six patients underwent ABP. The overall success rate of ABP was 58%. Twenty one were successful in first attempt (27.6%), a further 12/55 (22%) in the second and 11/43 (25%) in third attempt. The success rates did not differ significantly with etiology of spontaneous pneumothorax (P = 0.706); smoking status (P value = 0.958); duration of air leak prior to ABP (P= 0.149) and presence of residual pneumothorax after chest tube insertion (P= 0.176). Seven complications (3 pleural infections, 1 surgical emphysema, 1 expansion of pneumothorax and 2 recurrence) occurred. Infectious complications occurred in patients who received two or more instillations of blood.

Conclusion: ABP achieved a modest success rates in our experience. Two or more attempts may be necessary to attain a successful result but one has to be mindful of the possibility of infection.

Keywords: Broncho-pleural fistula; persistent air leak; pneumothorax.

Introduction

Spontaneous pneumothorax is a common thoracic surgical problem. They can follow rupture of bullae in patients who have chronic obstructive pulmonary disease (COPD) i.e. secondary spontaneous pneumothorax (SSP). They can also result from rupture of subpleural blebs in young patients with otherwise normal lungs i.e. primary spontaneous pneumothorax (PSP).[1] When spontaneous pneumothorax is complicated by a broncho-pleural fistula (BPF) and resultant persistent/prolonged air leaks (PAL), it is often a difficult problem to manage.These patients are usually treated conservatively with prolonged chest drainage, use of negative suction, physiotherapy and trial at pleurodesis with tetracycline, povidone iodine, talc etc. Heimlich valves have also been used with some success.[2,3] Although all the above methods have been employed with some success, none have seen to be universally effective or even entirely safe. Also, there remains the risk of recurrence and significant morbidity.[4]

The use of Autologous blood instilled through the chest tube in an attempt to close air leaks was first described by Robinson in 1987.[5] Many subsequent authors have described its use in management of PAL after pulmonary resections and after hydatid cyst operations[6-9] The success of ABP has been varied in reported literature with success rate as low as 27% and also upto72-100%.[10-12]

We conducted this study to evaluate the success rate of ABP in a large population of patients with BPF of spontaneous onset. We assessed the success rate of ABP, the number of attempts of ABP required in successful cases and the complications encountered.

Methods

This study was conducted prospectively in the Thoracic Surgery Unit of the department of Cardio-thoracic and Vascular Surgery of the Manmohan Cardio-thoracic Vascular and Transplant Center, Institute of Medicine, Tribhuvan University. Ethical clearance was obtained from the Institutional Review Board of the Institution of Medicine prior to initiation of the study. Informed consent was taken from each patient prior to enrollment. All patients with spontaneous pneumothorax (on Chest X-ray) and BPF which persisted after 48 hrs of conservative treatment (chest tube insertion and suction of -20 cm of water) were included in the study. The exclusion criteria were: evidence of pleural infection (frank pus or positive pleural fluid cultures); anemic patients with hemoglobin <10gm%; secondary pneumothorax; and prior attempts at pleurodesis.

As a preparation for possible operative treatment the patients were investigated with a high resolution CT (HRCT) scan.

Technique of ABP: The patients were explained in detail about the procedure to begin with. They were also taught to report immediately any shortness of breath (SOB) or sudden swelling of the body (surgical emphysema). The chest tube and drainage system were modified. Using an aseptic technique, a three way 3/8 connector with a luer-lock side port was inserted between the pleural drain and the tubing leading to the underwater seal. This device not only connected the chest tube to the drainage system but also provided an extra port with a cap which was used to introduce the blood into the chest in a sterile fashion without having to make a needle stick hole in the chest tube itself or having to even temporarily disconnect the tube from the drainage pipe which has been described by others.[8] The drainage tube itself was also lengthened with the addition of another two meter tubing. This was done to allow adequate length for the tube be looped over an Intravenous (IV) stand. The patient was put off suction.

Fifty milliliter of blood was drawn from the cubital vein of the patient in a 60 ml syringe which was not heparinized. The drainage tube distal to the three-way connector was briefly clamped using an artery clamp. The blood was then immediately and quickly injected through the port. This was followed by 30ml of sterile Normal Saline in order to avoid clogging of the blood in the tube. The port was then closed. The drainage tube was looped on top of an IV stand placed by the patient's bed. The artery clamp was then released. This allowed the blood to enter and stay in the thoracic cavity. Looping the drainage tube allowed us to avoid having to clamp the tube which could have increased possibility of tension pneumothorax and surgical emphysema. The patient was then asked to change positions every 15 minutes for two hours to ensure a uniform distribution of the film of blood on the entire pleural surface. No preemptive analgesia or sedation was used.

The patient was then watched closely for shortness of breath (SOB), onset of surgical emphysema and evidence of infection (change in color of chest tube fluid; fever; rising counts). If the patient developed SOB or surgical emphysema, the tube was immediately checked for function. If it was found to be blocked, attempts were made to de-clog. If this was unsuccessful, the chest tube was replaced and the further procedure was abandoned. If a subsequent X-ray done at this time showed that the lung had fallen back, the patient was re-initiated on negative suction. If the patient showed any features suggestive of infection, the pleural fluid was collected for bacteriological assessment. If found positive, the patient was treated with antibiotics and no further attempts at ABP were made.

The patient was evaluated at 12, 24 and 48 hours for the cessation of air leak. If at any of the assessments, there was no bubbling of air in the underwater seal drain system on deep inspiration and on forceful coughing, a repeat chest X-ray was done. If this chest X-ray showed a fully expanded lung and no evidence of loculated collection, the tube was left for a further 24 hours to allow some pleurodesis and then removed. If the air leak was found to be persistent at 48 hours of the instillation of blood, the patient was reassessed for re-instillation. In the absence of subsequent development of any of the exclusion criteria, the procedure was repeated. The procedure was repeated a maximum of two times making a total of three attempts at blood patching. If the patient was found to still have persistent

air leak at 48 hours after the third instillation of blood, the procedure was deemed to have failed. These patients were subjected to either continued conservative management or surgical treatment depending on their physiological status, CT scan findings and patient preference.

Data Collection: Data collection was done with the help of a structured Performa. The data was collected by the investigator and residents working in the Thoracic Surgical Unit during the period of study. The demographic data in terms of the age, sex, address, smoking status, type of spontaneous pneumothorax (SSP Vs PSP), high resolution CT scan (HRCT) findings, and time from onset of pneumothorax to first episode of ABP were recorded. The success/failure of ABP, if successful the number of attempts needed and the number and complications encountered were also recorded.

Data Analysis: Data was entered and analyzed in SPSS version 20. Mean ± SD was calculated for age, duration of leak before ABP and size of pneumothorax. Frequency and percentage were calculated for gender, smoking status and outcome variable i.e. success rate of ABP (Yes/No). Effect modifier was controlled through stratification of age, gender, duration of leak before ABP, size of pneumothorax and smoking status to see the effect of these on outcome variables. Post stratification, difference in success rates were compared using Chi square test taking P≤ 0.05 as significant.

Results

Of 106 patients admitted with pneumothorax between July 2011 and January 2014, thirty patients were excluded (18 were secondary; in 10 there was resolution of pneumothorax and air leak with conservative management; two had evidence of pleural infection at presentation). Seventy-six patients were included in the study.

The demographic data of the included patients were as presented in Table 1. The radiological findings of these patients were as detailed in Table 2. Based on the HRCT findings, forty seven patients had evidence of underlying bullous lung disease and interstitial lung disease (ILD) to which the spontaneous onset of pneumothorax could be attributed i.e. SSP. Twenty nine patients had either subpleural blebs only or normal HRCT with no underlying lung disease to which the spontaneous onset of pneumothorax could be attributed i.e. PSP.

ABP was successful in sealing the broncho-pleural fistula and ceasing the air leak in 44 patients (57.9%). Among patients in whom ABP was successful, in 21 patients (27.6%) the air leak ceased after the first episode of instillation. Among patients who required a second attempt, the procedure was successful in twelve patients (12/55 = 21.8%). The third attempt was successful in eleven patients (11/43 = 25%). (Table 3)

We compared the patients with PSP and SSP. The age of patients with PSP was 8-44 years (24.4± 8.2 years) while the age of those with SSP was 25-80 years (59.2±10.9 years). While all patients with SSP except a 25 year old man with ILD had history of smoking (10-50 pack years, mean = 24.3±12.6 pack years), only seven patients with PSP had history of smoking. The duration of air leak prior to ABP was shorter in PSP when compared to SSP.ABP was slightly more successful among patients with SSP (28/47 i.e. 59%) than among patients with PSP (16/29 i.e. 55%). However this did not reach statistical significance with a P value of 0.70.

When patients were stratified with respect to their age into young ≤ 40 years and ≥41 years, the success rates were not different (54% and 60% respectively P value = 0.51). There was also no difference in success rates between the sexes. (M=63%, F=50% P value=0.47)

The success rate of ABP among non-smokers (14/24 i.e. 58%) was similar to that among smokers (30/52 i.e.57.6 %); P value = 0.98. ABP success was found to be better in patients in whom the procedure was done ≤ 5days after the onset of pneumothorax (20/30 i.e. 66%) when compared to those in whom there was a delay of ≥ 6 days (23/46 i.e.50%). This too, however did not reach statistical significance (P value = 0.149). The difference in success rate in patients who did and did not have residual pneumothorax also did not reach statistical significance. (P value = 0.17).

Thirty two patients failed ABP. In thirty patients despite three attempts, the blood instillation failed to stop the leak. In two patients, blood patching had to be stopped after the second episode because the patient developed complications. In patients who failed ABP, 26 were subjected to surgery.Two patients who failed ABP could not be taken for surgery (one patient was deemed unfit for surgery due to poor general condition and one patient because she was in her third trimester of pregnancy). They were discharged with chest tube in-situ when it was clear the lung did not further fall back despite putting the chest tube of suction. They were followed up in the out-patient department every week.

A total of seven complications were encountered (Table 4). Three patients developed evidence of pleural infection. In two patients this was identified after two episodes of blood

instillation and one patient developed infection after the third episode. All these three patients had failed ABP and had two or more attempts at ABP. They were all treated with systemic antibiotics and irrigation of antibiotics through the chest tube. One patient (80/M) developed moderate surgical emphysema after the third instillation. The tube was found to be blocked, a second chest tube was inserted and patient was put back on -20cm of suction. One patient (20/F, pregnant) developed dyspnea after the third instillation, a chest X-ray showed further collapse of the lung. The chest tube was manipulated and was attached back to the suction after the chest tube was functional. The rate of complications post ABP did not differ between those who had first episode of ABP ≤ 5days Vs ≥ 6days (P= 0.67) and between smokers and non smokers (P=0.85) and between PSP and SSP patients.

Post discharge, the patients were followed up at 1 week, 1 month and 3 months. During the period of this study recurrence after a successful ABP was encountered in two patients. Both these patients were treated with chest tube insertion and subsequent pleurodesis. On analysis of the occurrence of the complications, it was noticed that all complications other than the recurrence occurred in patients who had had two or more attempts at ABP. The rate of complications among patients who had a successful outcome was 2/44 (4.5%) and among those who had an unsuccessful outcome was 5/32 (15.6%). There was no statistical significance in the difference (P value = 0.09)

Discussion

In our series, a large proportion of patients with spontaneous pneumothorax underwent ABP.This is because we have chosen to apply ABP after only 48 hours of failed conservative management. Most other series have reported using ABP between five and nine days after conservative treatment.[13-15] Although some authors have waited up to five weeks[6] before applying ABP, it is intuitive that the longer the chest drain has been in-situ, the greater the likelihood of colonization of the chest tube with bacteria. This could potentially exacerbate chances of infection in the pleural space when performing ABP. Also it is believed that the autologous blood patch technique is likely to be effective within the first few days of the development of the air leak. It has been postulated that it may be that blood instillation earlier after the initial injury to the lung is more successful in sealing the leak, as the blood may be more likely to adhere to the damaged lung and form a clot at this time.[16] It was for this reason and also because our patients came to us an average of five days after the onset of pneumothorax it was deemed better to opt for an early application of ABP. A similar approach has been taken in another large series dealing with ABP in similar clinical situation.[10]

The success of ABP in our series is considerably lower than in many reported series.[5,13,14] It is possible to explain when we look more closely to the specific aspects of our methodology and the nature of previous reports. Almost all previous reports are severely limited by their small sample size. Therefore, the true success rate of this procedure would be difficult to decipher based solely on small scale studies. The review by Chambers et al.[13] has shown very high success figures. However, it is faulted by the non-inclusion of some recent papers which have reported very modest results. In a recent series, success was attained in 6/10 patients with inflated lungs and 4/7 patients whose lungs were in a collapsed state.[15] Another study with 15 patients reported 27% success in closing air leak after a single instillation when patients were assessed after 24 hours of instillation.[12] These observations more closely mirror our own findings of 27.6% success after first instillation. Our use of only 50ml of blood for each instillation unlike some others who have used 100ml[15]- 200ml[17] may have potentially affected our success rates. We did this to minimize the possibility of infectious complications.

One significant finding in our series was that although the overall success rate was 58%, only 27.6% (21/76) of our patients had a successful outcome on the first instillation of blood. Success was achieved in the second attempt in 21% (12/55) and third attempt in 25% (11/43). This result not only closely resembles that of some previous reports[13,18] but also implies that more than one attempt at ABP would hold a reasonable chance of success. This would hold special importance in patients who are poor surgical risk.

Infection related complications are major concerns with ABP. Prior reports[19] have demonstrated upto 28% (3/28) rates of empyema and nearly 20% (2/11) rates of fever.[8] Three of our 76 (4%) developed pleural infection which although significant is much smaller complication rate than previously reported. We followed an absolute adherence to the contraindications and made the effort to rule out pre-existing infection. Also, a careful sterile technique of maneuvering the tube was applied. We used a comparatively small amount of blood for ABP. These factors may have helped to keep our infection rates low. However, we did notice that all our infection related complications occurred in patients in whom two or more instillations were required. This probably had to do with the consequently higher volume of blood that was instilled and also longer duration of the treatment. We experienced recurrence in 2/76= 2.6% recurrence of pneumothorax. This probably is a testament to the poor pleurodezing ability of blood.

We have not studied the effect of the different doses of blood instilled on the outcome of ABP and our follow-up is short so delayed complications of this procedure like delayed onset pleural space infection and late recurrences may be missed. These are significant limitations of our study.

Conclusion

In our experience ABP achieved a modest success rate (nearly 60%). Two or more attempts may be necessary to attain a successful result but one has to be mindful of the possibility of infection. A direct comparison of the technique with operative repair of PAL may give more insight as to its real value especially in patients who are marginal or poor surgical candidates.

Table 1.Demographic data of patients.

Number of patients(N)	76
Age	18-80 years (mean =45.9 ± 19.9)
Sex ratio (M:F)	4:1
Address	Inside Kathmandu Valley = 27 Outside Kathmandu Valley =49
Smoking history	Never smokers = 24 Current/past smokers = 52 with 3-50 (mean =23.1± 12.0 pack years) history
Duration between onset of pneumothorax and first attempt of ABP	2-20 (mean =7.5 ± 4.3 days) For patients who came from within Kathmandu = 7.1± 4.9 days For patients being referred from outside Kathmandu = 7.8 ± 4.1 days

Table 2: Radiological findings:

CXR findings after chest tube insertion and suction	Full expansion = 13 ≤ 20% residual pneumothorax =37 ≥ 20% residual pneumothorax = 26
High resolution CT scan findings	Normal =9 Apical blebs only = 19 (10 on right, 9 left), Bullae = multiple bullae on HRCT in 44 patients (19 on the right, five on the left, 20 had bilateral bullae). Hyperinflated emphysematous lung, no bullae = 1 ILD=2 HRCT not done = 1

Table 3: Success rates of ABP.

Overall success rate observed	44/76 = 57.9%
Success rates according to number of attempts	First attempt = 21/76(27.6%) Second attempt = 12/55 (21.8%) Third attempt = 11/43 (25%)

Table 5.List of complications.

Complication	Frequency
Empyema	3
Surgical emphysema	1
Expansion of pneumothorax	1
Recurrence	2

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