Perioperative Pneumoperitoneum after Lobectomy - Bilobectomy Operations for Lung Cancer: A prospective study

M S NABI * A BILAL K FAROOQ
Department of Thoracic Surgery, Mayo Hospital Lahore.
**Department of Cardiothoracic Surgery, Postgraduate Medical Institute, Lady Reading Hospital, Peshawar.*
Correspondence to Dr. Muhammad Shoaib Nabi, Senior Registrar, E-mail

The aim of this study is to identify the effectiveness of perioperative pneumoperitoneum to prevent air leak after the lobectomy-bilobectomy operations for lung cancer. A prospective study was designed on consecutive 50 patients who had lobectomy-bilobectomy operations for lung cancer and whose remnant lung had failed to fill the half of the hemithoracic cavity under 30 Cm H_20 positive pressure ventilation during the operation with totally relaxed diaphragm. The patients were divided into two groups: group 1(25 patients) with perioperative pneumoperitoneum, group 2(25 patients) without perioperative pneumoperitoneum. The statistical analysis between the two groups did not show any significant difference in terms of age, preoperative FEV_1, and the type of resection. Perioperative pneumoperitoneum significantly reduced the duration of postoperative air leak (2.2+/-1.15 day versus 6.04+/- 3.16 days<0.0001) and total chest tube drainage time (3.84 +/-0.98 day versus 7.88+/-3.16 days p<0.001). Perioperative pneumoperitoneum after lobectomy-bilobectomy operations for lung cancer is an effective method to decrease air leak and chest tube drainage time.

Key Words: Pneumoperitoneum, lobectomy-bilobectomy, air leak.

Prolonged air leak, which is almost always associated with residual pleural space, is one of the most frequent complications of pulmonary resections. Residual pleural space prevents the raw surfaces of the remaining lung to get in apposition with the parietal pleura, thus prologs paranchymal air leak from the remnant lung. Nature helps the residual lung to fill the pleural space by approximating the ribs of the operated side, by the shift of the mediastinum and by the elevation of the diaphragm unless each had been operated or fixed by other causes[1].

We performed pneumoperitoneum to help the elevation of the diaphragm. We hypothesized that it could be easier to inject air under the diaphragm at the time of thoracotomy through a small opening in the diaphragm. We also theorized that by performing pneumoperitoneum (PnP) at the time of thoracotomy, we could avoid both the morbidity associated with percutaneous catheter placement and pain due to insufflation of air. The aim of this study was to assess the effectiveness of this procedure in candidates of residual pleural space and air leak in a prospective design.

Patients and methods

This prospective study was enrolled in department of cardiothoracic surgery, Postgraduate Medical institute, Lady Reading Hospital, Peshawar from 1997 to 2001. The study group was consecutive 50 patients with lobectomy-bilobectomy for lung cancer whose remnant lung had failed to fill the half of the hemithoracic cavity under 30 cm of H_20 positive pressure ventilation with totally relaxed diaphragm. We applied pneumoperitoneum in the first 25 patients. The control group was selected from other 25 patients who did not have PnP. The patients were divided into two groups: group I, with PnP procedure (25 patients); group 2, without PnP procedure (25 patients). All operations were performed by the same surgical team through a posterolateral thoracotomy with a double lumen tube intubation. Bronchus stapler was used in all bronchial closures. In separation of the fissures, linear staplers were used when the fissure was incomplete. In others after separation, 3/0 polyprolene monofilament sutures in continuous technique was used to stop air leakage. Warm sterile water was squirted over the lung to localize air leaks and all leaks were sutured with the 4/0 polyprolene sutures. In upper lobectomies and Bilobectomy inferior pulmonary ligament was dissected up to the inferior pulmonary vein. After upper and lower lobectomies of the right side, middle lobe was fixed to the remaining lobe to prevent lobar torsion. All patients had alveolar leakage under 30 cm H_20 pressure of ventilation and none of them had bronchial stump leakage. To perform PnP a purse string suture was inserted on the anterolateral part of the diaphragm. A stab wound was made on the diaphragm within the purse string suture by taking up the diaphragm with a haemostatic clamp, diaphragm was dilated. The dome of the liver on the right side, the stomach on the left side and the free peritoneal cavity were visualized. A 10F feeding tube with a 3-way stopcock behind was inserted through the diaphragm. With the aid of a 50 ml syringe, room air was injected until the diaphragm was distended. The mean amount of injected air was 1030 ml (800 – 1500 ml, approximately 15 ml/kg). Patients one chest tube was positioned apically and one along the diaphragm. All patients had intraoperative analgesic intercostal blockage and received the same nonsteroid analgesic therapy and none of the patients in both groups received additional analgesic. Chest roentgenograms were performed right after the operation and daily. All chest tubes were kept on

20 cm H_2O suction until the morning of postoperative day 1. If chest X-Ray confirmed a totally expanded lung without any air leak, we stopped suction and placed water seal. If a residual space was noticed we continued suction with 20 cm H_2O whether air leak was present or not. If air leak was present with totally expanded lung we kept on suctioning. We switched to intermittent suctioning after postoperative day 3 if an air leak persisted. During the postoperative period the effusion was less than 200 ml in 24 hours even when a residual air space was present. An air leak which lasted longer than 7 days was considered as prolonged air leak. The patients who had chest wall resection, previous abdominal operation and postoperative mechanical ventilation were excluded from the study. Any of the following postoperative events were considered as complication: pulmonary atelectasis or pneumonia, respiratory or ventilatory insufficiency (PO_2 less than 60 mm Hg or PCO_2 over 45 mm Hg), need of mechanical ventilation at any time, after extubation at the operating room, pulmonary thromboembolism, arrhythmias, myocardial ischemia or infarct and clinical cardiac insufficiency. Operative mortality was defined as any death that occurred during the hospitalization period or within 30 day after the operation.

Statistical analysis:

For the statistical analysis between the two groups, the Student T test was used in terms of age and pulmonary function tests and Mann Whitney-U test was used to determine the significance in type of resection, air leakage time and drainage time.

Results

Statistically no significant difference in terms of age, type of resection and preoperative forced expiratory volume in 1 second was identified. The mean age was 58.2+/- 8.0 years (48-82 years) in group 1, 57.5+/- 6.1 years (30-65) in group 2 (t:0. 1324, p:0.8952). No significant difference was noted in terms of resection type (Mann Whitney U: 312.00 p: 1.00). The mean length of air leak was 2.2 +/- 1.15 days (1-4 days) in group 1, 6.04 days +/- 3.27 in group 2 (2-14 days) (Mann Whitney U:70.500 and $p<0.0001$). The difference between two groups was statistically significant. The mean length of total tube drainage time was 3.84+/- 9.98 days in group 1 and 7.88+/-3.16 days in group 2 (Mann Whitney U: 46.500, $p<0.001$). The patients characteristics are summarized in Table 1. Postoperative complications were noticed in 2 patients in group 1, and 5 patients in group 2. In group 1, 1 patient had supraventricular tachycardia and 1 patient developed pneumonia. In group 2, 2 patients required noninvasive mechanical ventilation for 2 more days after extubation, 1 patient had atelectasis that required bronchoscopy, 1 patient developed tachycardia and 1 developed cardiac insufficiency. In group 1, 3 (% 8.33) patients had residual postoperative non complicated pleural space whereas in group 2, 8 (% 32) patients had residual postoperative non complicated pleural space.

Table 1: The comparisons among patients with and without pneumoperitoneum.

	Group I	Group 2	P value
Age	58.2+/- 8.0 years	57.50+/- 6.1 years	0.89*
FEVI	2110.65 ml+/- 405	2213.20 ml+/- 780	0.89*
Resection	4:LUL 7:LLL 3:RUL 6:RLL 5:RLB	4:LUL 6:LLL 7:RUL 4:RLL 4:RLB	1**
Air leakage Time	2.2+/- 1.15 days	6.04+/- 3.270	<0.0001 *
Chest tube drainage time	3.84+/- 0.98 days	7.88+/- 3.16 days	<0.001* *

LUL: Left upper lobectomy, LLL: Left lower lobectomy, RUL: Right upper lobectomy, RLL: Right Lower Lobectomy, RLB: Right lower bilobectomy

*unpaired student *t-test*, **Mann Whitney U test.

Discussion:

After lobectomies, reexpansion of the remnant lung to obliterate the pleural space is desired. With the reexpansion of the remaining lung, elevation of the diaphragmatic leaf and shift of the mediastinum towards the ipsilateral side, pleural space is usually obliterated within several days to a week[2]. Most air leaks are the result of inadequate or failed closure of distal bronchioles or alveolar spaces which almost cause no mortality but significant morbidity in a group of patients with abnormal compliance of the residual lung[1]. The need for assistance in reducing the size of pleural space is almost always recognizable at the time of surgery. Temporary phrenic nerve paralysis which was utilized frequently in the past to increase the diaphragmatic elevation is not suggested today. The resultant paralysis of the ipsilateral leaf of the diaphragm however permits paradoxical motion of this portion of the thoracic cavity. Although this effect is of no real consequence during normal breathing, the paradoxical motion of this paralyzed leaf does interfere with the efficacy of the cough mechanism[3].

The creation of the pleural tent after upper lobectomies to reduce the size of hemithoracic cavity and to decrease the length of chest tube duration is well documented in two prospective randomized studies[4,5]. This procedure is reported to be reserved for upper lobectomies and upper and middle (bilobectomies) only. For the upper lobectomies, pleural tent is our first choice for obliteration of the pleural space. Pleural symphysis which is generaly located in the apex of the thoracic cavity may cause defects in the parietal pleura during dissection of the lung. In such a case creation of a pleural tent may be impossible in upper lobectomies performed for tuberculosis or lung cancer with parietal pleura adhesion. New products are

currently being developed to treat air leaks during operation, but many of them are expensive (patches, glues and sealants). These new products or PnP could be applied for air leak in the descripted scenario. Our goal was to develop a simple, effective, inexpensive and safe method which was available to all thoracic surgeons to manage air leaks.

Perioperative pneumoperitoneum after lung resections had been considered in the past and postoperatively after lung volume reduction operations recently [1,6,7]. In our previous report about perioperative pneumoperitoneum, we recognized that the mean duration of air leakage was 2.18 days (12 hours-4 days)[8]. In this study none of the patients were observed as having residual air space in their postoperative chest x-ray Preliminary reports about 14 patients stated that after injection of air under the diaphragm perioperatively, no complication related to the procedure was noticed and the method was offered as a safe, economic and effective method[8].

The present study showed approximately 4 days of reduction in the mean duration of air leak in PnP group and also 6 patients (24%) experienced prolonged air leak in group 2. The indication for PnP was failure of the remnant lung to fill the half of the hemithoracic cavity under 30 cm H_20 pressure after resection. The non PnP group had longer air leak because they had residual pleural space with no preventive measurement. Although the groups were statistically uniform in preoperative and operative aspects, there was a difference in postoperative chest tube duration time.

Percutaneous methods for PnP are well known and being offered in two recent studies[9,10]. In studies air was injected under the diaphragm via Veres needle. In one of these studies[9] 1200-1300 ml of air and in the other[10] 2100ml of air were injected. Both studies reported successful results without any complication, except a slight increment of carbon dioxide partial blood pressure in blood gas analysis[10]. Talc slurry was also used in some patients to help air leak control[10]. The procedure was offered because it is safe, effective and easy to perform.

We believe postoperative percutaneous procedures should be done as early as possible, because the residual lung could form adhesiveness with thoracic wall in a few days and PnP would not help the remnant lung to move towards the apex. Our experience for postoperative percutaneous methods on patients with residual pleural space other than the study group, which wee applied on days 4, 5,7,10 on 4 patients were not successful, although the injected air was almost twice as the perioperative applied volume. Moreover morbidity due to percutaneous catheter placement and pain due to insufflation could not be ignored. Also air may not get to desired position which is necessary to elevate the hemidiaphragm if compartmentalized adhesions were present in the peritoneal cavity.

In a study, intraoperative pneumoperitoneum was applied to 11 lower Bilobectomy patients, enabling a shorter hospital stay which was statistically significant in comparison with lower Bilobectomy without pneumoperitoneum[11]. We shared the same experience with Carbognani and associates [11]. In this study we applied PnP to all type of resections and noticed that PnP procedure was an effective method to decrease air leak time in also upper lobe resections like presented in percutaneous postoperative methods[9,10]. Thus we offer to apply PnP after lung resections whose remnant lungs had failed to fill the half of the hemithoracic cavity under 30 cm H_20 pressure with totally relaxed diaphragm. In an other prospective randomized study on lower Bilobectomy (middle and lower lobectomies) patients, 8 patients received PnP intraoperatively and 8 did not[12]. Both groups were similar, like our study, in terms of preexisting conditions including all preoperative data. Results favored PnP group in the length of hospital stay, in the prevalence of air leak and residual pneumothoraces[12]. Thus Cerfolio[12] offered to use this method.

The complications that occurred in the postoperative period were specific for thoracic surgery. We believe none of them is related to the procedure itself. Residual pleural space was noticed in both groups. This may raise a question about the reason of lesser time of air leak in PnP group. The amount of residual space and raw contact surface of lung are not unique. In PnP group residual space was lesser and the remaining lung gets in apposition with larger area with the parietal pleura. We believe PnP worked by achieving more visceral and parietal pleural apposition. We noticed that PnP was reabsorbed generally within 3 weeks.

Further studies on perioperative pneumoperitoneum are necessary. Studies should mainly confirm the data of postoperative FEV 1, measurement of diaphragmatic movement and the effect of PnP on the diaphragmatic inspiration. On the other hand intraabdominal pressure during PnP application can be recorded. By this way dangerous side effects of PnP procedure with high pressure can be prevented and a standard pressure can be defined with therapeutically effective measure for air leak treatment.

The advantages of perioperative PnP procedure could be summarized as follows:

1. It can be applied to all groups of lobectomy-bilobectomy resections as a preventive method for air leak.
2. Lesser amount of air is injected when compared to postoperative percutaneous methods.
3. It is cheap and not a time consuming procedure a
4. It is safe (not a complication related procedure). In clinical practice, we noticed that, PnP does not interfere with the postoperative pulmonary capacity.
5. It causes no pain when applied intraoperatively.
6. It is an effective method to decrease air leak time.

Reference

1. Rice TW, Kirby TJ, Prolonged air leak. Chest Surg Clin North Am 1992; 2:803-11.
2. Shields TW. General features of pulmonary resections. In; Shields TW, Lo Cicero J, Ponn RB, eds. General Thoracic Surgery. Philadelphia: Lippincott Williams & Wilkins: 2000:375-384.
3. Shields TW. General features and complications of pulmonary resections. In: Shields TW, ed. General Thoracic Surgery. Philadelphia: Williams & Wilkins; 1994:391-414.
4. Brunelli A, Refai MA, Muti M, Sabbatini A, Fianchini A. Pleural tent after upper lobectomy: a prospective randomized study. Ann Thorac Surg 2000; 89:1722-4.
5. Okur E, Kir A, Halezaroglu S, Alpay L, Atasalihi A. Pleural tenting following upper lobectomies or bilobectomies of the lung to prevent air space and prolonged air leak. Eur J Cardio-thoracic Surg 2001; 20:1012-5.
6. Deslauriers J. Indication for completion pneumonectomy. Ann Thorac Surg 1988;46:133-9.
7. Handy JR, Judson MA, Zellner JL. Pneumoperitoneum to treat air leaks and spaces after lung volume reduction operation. Ann Thorac Surg 1997; 64:1803-5.
8. Toker A, dilege S, Bostanci K, Kalaycl G. Perioperative pneumoperitoneum to prevent space and air leak after lobectomy operation. Turkish Respiratory Journal 200; 1:9-11.
9. Carbognani P, spaggiari L, Solli PG, Tincani G, Bobio A, Rusca M. Postoperative pneumoperitoneum for prolonged air leaks and residual spaces after pulmonary resections. J Cardiovasc Surg 1999; 40:887-8.
10. De Giacomo t, Rendina EA, Venuta F, Francioni F, Moretti M, Pugliese F, Coloni GF. Pneumoperitoneum for the management of pleural air space problems associated with major pulmonary resections. Ann Thorac Surg 2001;72;1716-9.
11. Carbognani P, Tincani G, Galiimberti A, Cattelani L, Bobbio A, Rusca M. The bilobectomies for lung cancer. J cardiovasc Surg 2001; 42:421-4.
12. Cerfolio RJ, Holman WL, Katholi JR. Pneumoperitoneum after concomitant resection of the right middle and lower lobes (bilobectomy). Ann Thorac Surg 2000; 70:942-6.