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Autologous Reflected Pericardial Flap Coverage of Post-Resection Bronchial Stump; Was it Effective in Preventing Broncho-Pleural Fistula in Children?

Ahmed H. Lamloum*[1], Ihab Mohamed Salah Eldin Elsharkawy[1], Hassan Alsisi[1], M. ElZayadi[2], Mahmoud A. Wkeel[3], Ahmed M. Elwakeel[1]

Departments of [1]Cardiothoracic Surgery and [3]Anesthesiology, Faculty of Medicine, Cairo University, Egypt

Department of [2]Cardiothoracic Surgery, Faculty of Medicine, Fayoum University, Egypt

***Corresponding author:** Ahmed H. Lamloum, **Mobile:** (+20) 01017886273, **E-mail:** alamloumcts@gmail.com

ABSTRACT

Background: Postoperative broncho-pleural fistula (BPF) is a major surgical complication that may be life-threatening in some cases. Many prophylactic surgical techniques were claimed. However, the best method to be used is not yet settled. **Objective:** In this study, we investigated the efficacy and safety of an autologous reflected pericardial flap in protecting against such a serious condition in the pediatric population. **Patients and Methods:** Between January 2018 and June 2023, 202 patients who underwent lung resection surgery for congenital and/or infective causes at Kasr Al-Ainy and Fayoum University Hospitals were divided into two groups: group A (104 patients with no coverage techniques) and group B (98 patients with pericardial flap coverage). **Results:** Over the mean follow-up duration (21.02±9.76 months), postoperative air leakage occurred in 10 patients. 9 (8.82%) of which belonged to group A, and only 1 diabetic patient (1.02%) was among the coverage method group that denoted a statistically significant difference (P value = 0.0116). Postoperative hospital stays and need for reintervention were also significantly lower in group B (2.02 ± 0.60) vs. group A (6.13 ± 1.65) and 8 patients needed intervention in group A vs. 1 patient in group B, with a p value< 0.05). **Conclusion:** In-hospital results of bronchial stump covering with pericardium were favourable in terms of postoperative morbidity and mortality, indicating its efficacy and safety in preventing postresection bronchial stump dehiscence.

Keywords: Lung resection, BPF, Autologous pericardial flap coverage.

INTRODUCTION

Streptococcal infections, necrotizing pneumonia, developmental lung anomalies, frequent bronchoscopy interventions, right-sided resections, and poor surgical techniques are all well-known risk factors for post-resection bronchial stump dehiscence[(1-3)].

Many surgical precautions and procedures, including the avoidance of lymph node resection for non-malignant reasons, muscle flap covering, and endobronchial device occluder for the fistula, were claimed to avoid such significant consequences. However, each of these options may be inapplicable, costly, or dangerous especially in pediatric population[(4-6)]. Usage of the patient's own pericardium as a reflected flap to cover the at-risk stump was assumed to protect against ischemic necrosis, secondary infection, bronchial stump dehiscence that affects up to 20% of patients and carries high morbidity and mortality[(7,8)].

We aimed to study the efficacy and safety of an autologous reflected pericardial flap in protecting against postresection BPF in the pediatric population.

PATIENTS AND METHODS

Study design:

Between January 2018 and June 2023, information on 202 children who underwent lung resection procedures was gathered from Kasr Al-Ainy and Fayoum University Hospitals. The patients were divided into two groups: Group A, which included 104 patients for traditional non-coverage procedures, and Group B, which included 98 patients for pericardial coverage.

Definitions:

Any communication between the main stem, lobar, or segmental bronchus and the pleural space that causes pneumothorax or chronic air leak was described as a BPF [(9)].

Postoperative persistent air leak was defined as continuous air leak for more than 5 to 7 days despite whole conservative measures[(10)].

Re-intervention is required for post-resection BPF to be diagnosed clinically, via bronchoscopy, or with high-resolution computed tomography. Surgery was recommended when the BPF was more than 8 mm or when pleural drainage and conservative therapy did not improve the BPF[(11)].

Exclusion criteria:

Patients above the age of 16, patients with coexistent pericarditis (such as tuberculous lung and pericardial diseases and autoimmune pericarditis) and history of pericardiotomy (such as open-heart surgeries).

Methodology:

The identical protocols for anesthesia and surgical preparation were administered to each patient. Preoperative investigations were routine for all patients, including a full laboratory investigation, an ECG assessment of the heart, a chest X-ray with P/A and lateral views, enhanced computed tomography (CT), fiberoptic bronchoscopy, pulmonary function test (PFT; for appropriate ages), and postoperative follow-up regarding early (first month) outcome after operation.

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Anesthesia Technique:

Initially, patients were anesthetized in supine position. Standard monitoring was applied to the patient. Induction of GA was done using inhaled sevoflurane, then atropine, fentanyl 2 ug/kg, atracurium infusion at 0.2 mg/kg/hr. Appropriate size endotracheal tube was inserted. One lung ventilation was attained by mainstem bronchial intubation of contralateral side. Pressure controlled mode of ventilation was chosen. Central venous line on same side and invasive arterial line was inserted; using ultrasound guidance. Then the patient was placed in the lateral decubitus. Erector spinae plane block was done on ipsilateral side.

Surgical Technique:

All of the patients were operated on while under general anesthesia, with a typical posterolateral thoracotomy. The lung was freed from the chest wall, and then, depending on the portion of the lung to be resected, the pulmonary artery, veins, and feeding bronchus were carefully dissected and then divided in the same order. Bronchial stumps were controlled using simple interrupted 3/0 Vicryl or Ethibond 2/0 stitches perpendicular to the divided bronchus.

In 98 children (48.51% of the total population) we harvested pedicled pericardial flap just close to the site of the bronchial stump. The free medial edge of the rectangular pericardial flap was then reflected and fixed to the primarily closed bronchial stump using 4/0 or 5/0 multiple simple stitches. Finally, in both groups, we used the under-saline test along with gradually increasing the airway pressure to do the air-tight seal protecting against postoperative air leak.

A CT scan was conducted on patients with symptoms suggestive of BPF, but a flexible bronchoscopy was finally used to make the final diagnosis. Patients with BPF were treated surgically with a simple chest drain, or in severely infected instances, re-exploration and use of a muscle flap or open window drainage might be carried out.

Sampling method:

From a total patient population of 430 cases, a suitable sample size (202 patients with more patients in the control group) was estimated correctly. This sample size was determined using the Medcalc 19 programme, with an alpha error of 5%, a 95% confidence level, and an 80% power sample, the equations was described according to **Machin *et al.* [(12)].**

Ethical approval:

Fayoum University's Ethics Committee authorised the study protocol [Ethical No.: R 524]. Each patient's guardian provided an informed written permission for the procedure. The Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis: SPSS V. 22.0 was used for all statistical analyses. For continuous data, the mean±Standard deviation were used, and for categorical data, frequency and percentages were used. A statistician from the department assisted with all statistical analyses. P values were all two-sided and deemed statistically significant when they were < 0.05.

RESULTS

[Data are presented as mean± SD, or n (%)]

A total of 202 patients (102 females) were divided into two groups: Group A (104 patients without bronchial stump coverage) and Group B (98 patients with pericardial flap coverage). The mean age of our sample was 2.045 (± 2.478) years old. There was no statistically significant difference between the two groups in any of the demographic or clinical baseline variables. The commonest cause for resection was congenital cystic adenoid malformation (C-CAM; 91 patients (45.05%)) (Table 1).

Table (1): Demographic and preoperative variables

	Total;104	Group A	Group B	P value
Age	3.40 (± 3.38)	3.56 (± 3.30)	3.58 (±3.38)	P = 0.9520
Female	102 (50.50%)	55 (52.88%)	47 (47.95%)	P = 0.3223
Main pathology				
C-CAM	91 (45.05%)	51 (49.03%)	40 (40.82%)	P = 0.0972
Broncho-pulmonary Sequestration	30 (14.85%)	18 (17.30%)	12 (12.24%)	P = 0.1523
Bronchogenic cyst	23 (11.39%)	13 (12.5%)	10 (10.20%)	P = 0.4667
Congenital lobar emphysema	18 (8.91%)	9 (8.65%)	9 (9.18%)	P = 0.8519
Lung Abscess	16 (7.92%)	8 (7.69%)	8 (8.16%)	P = 0.8614
Bronchiectasis	14 (6.93%)	7 (6.73%)	7 (7.14%)	P = 0.8713
Mycetoma ball	4 (1.98%)	1 (0.96%)	3 (3.06%)	P = 0.1331
Large Tuberculous cavity	2 (0.99%)	1 (0.96%)	1 (10.02%)	P = 0.9515
Invading Teraroma	1 (0.49%)	-	1 (10.02%)	P = 0.1547
Huge compressing Cystic Hygroma	1 (0.49%)	-	1 (10.02%)	P = 0.1547
RMB and RPA agenesis	1 (0.49%)	-	1 (10.02%)	P = 0.1547
Neglected Left BEF	1 (0.49%)	-	1 (10.02%)	P = 0.1547

C-CAM; Congenital Cystic Adenomatous Malformation, RMB; Right Main Bronchus, RPA; Right Pulmonary Artery, BPF; Broncho-Esophageal Fistula.

All lesions were approached through the conventional lateral thoracotomy through the fourth or fifth intercostal space. Trans-axillary excision of a long standing descending cystic hygroma compressing the upper lobe was used in a 4-year-old female. Anterior extension with add transverse sternotomy was performed for total excision of invading teratoma in a 3-year-old boy. Left lower lobectomy was the most common resection performed (78 cases (38.61%)), which may be explained by the profusion of lesions that commonly affect the left lower lobe in our age group, such as C-CAM and congenital lobar emphysema (Table 2).

Table (2): Intraoperative variables

	Total	Group A	Group B	P value
Left lower lobectomy	78 (38.61%)	43 (41.35%)	35 (35.71%)	P = 0.2447
Right middle lobectomy	42 (20.79%)	24 (23.07%)	18 (18.36%)	P = 0.2434
Left upper lobectomy	32 (15.84%)	18 (17.30%)	14 (14.29%)	P = 0.4074
Right upper lobectomy	28 (13.86%)	16 (15.38%)	12 (12.24%)	P = 0.3610
Right middle lobectomy	20 (9.9%)	12 (11.54%)	8 (8.16%)	P = 0.2668
Left pneumo-nectomy	1 (0.49%)	-	1 (1.02%)	P = 0.1506
Right Pneumo-nectomy	1 (0.49%)	-	1 (1.02%)	P = 0.1506

Early extubation policy [6 hours after operation[13]] was followed in all patients avoiding hazards of high mechanical ventilator pressure on the bronchial stump and for early mobilization and physiotherapy essential for remaining lung inflation to fill the residual space after the resection process.

Prolonged postoperative air leak affected 10 of our cases; 9 of them had no stump coverage compared to one diabetic 6-year-old boy with chronic right upper lobar abscess in whom we covered the bronchial stump using reflected pericardial flap (P value = 0. 0103).

Re-intervention for persistent postoperative air leakage was required in eight of the non-coverage group, where pericardial flap was our best choice in controlling such cases, compared to only one diabetic boy in the coverage group, where a pedicled intercostal muscle flap was used.

Postoperative mean hospital stays were significantly higher in the non-coverage group denoting better bronchial stump sealing in the coverage group.

All patients were followed up in our outpatient clinics by chest examination and chest X-ray every 3 months with mean follow-up duration of 21.02+9.76 months.

Table (3): Postoperative variables

	Group A	Group B	P value
Prolonged air leak	9 (4.46%)	1 (0.49%)	P = 0.0103
Re-intervention	8 (3.96%)	1 (0.49%)	P = 0.0182
In-hospital stay	6.13 ± 1.65	2.02 ± 0.60	P < 0.0001

DISCUSSION

Among complications of lung resection surgeries, BPF is considered as the most serious and handicapping complication[14]. It may follow necrotizing pneumonia or follow interventions to clear the airway or to respect the destructed lung tissues[15].

Many surgical control techniques for BPF have been introduced. However, the best simple method is not yet settled. In this study, we introduce a new simple technique in pediatric population suffering such serious condition.

The use of a pedicled intercostal muscle flap carries the risk of heterotopic calcification with subsequent flap necrosis and stump dehiscence[14]. Despite its effectiveness in the prevention and treatment of BPF, omental flaps require additional abdominal and diaphragmatic incisions[16, 17].

After examining the postoperative changes of a free pericardial fat pad attached to the bronchial stump, **Nagashima *et al.*[18]** discovered a noteworthy decrease in the amount of adipose tissue after six months. Usage of free pericardial pad of fat was proved to be associated with gradual decrease in size due to necrosis and sloughing that may lead to delayed stump dehiscence[19]. We believe that the use of pedicle flaps rather than free-harvested tissue would be more appropriate in light of the possibility of BPF in certain individuals at a very late stage.

Depending on the fact that pedicled pericardial flap actively produces various angiogenic and growth factors that may help the healing of the bronchial stump[20]. We sought to prove the effectiveness of the simple reflected autologous pericardial pad of fat in preventing and controlling post-resection bronchial stump dehiscence.

In 2019, **Klepetko *et al.*** [21] published a cohort study of 129 patients and discovered that covering the bronchial stump reduced the incidence of BPF. There were no BPFs in the high-risk group, where pericardial flaps were used exclusively. That coupe well with our results where only one case among the coverage group suffered postoperative BPF.

Wright and colleagues reported their findings of 256 patients after pneumonectomy and attributed the low prevalence of 3.1% PBPF to their coverage strategy, wherein the pericardial flap was employed in

just 2 out of 8 patients with postoperative BPF[22]. This also coincides with our findings.

In contrary, in their cross-sectional study, **Skrzypczak *et al.*** [23] found no significant impact of the bronchial stump closure on incidence of post-resection BPF.

2020 saw the reporting of BPF in 8 lobectomy patients (1.7%) and 10 pneumonectomy patients (11.1%) by **Caushi *et al.*** [24] While no coverage was done for patients with post-lobectomy BPF, 6 (10.7%) of the cases with post-pneumonectomy BPF had bronchial stump coverage; however, these findings weren't statistically significant ($p > 0.05$). This also is inconsistent with the results we found.

CONCLUSION

Many local and international inquiries have demonstrated the usefulness of bronchial stump covering as a preventive and curative surgical method for post-resection BPF. However, little information is available on the optimal covering flap or graft.

In this study, the autologous reflected pericardial flap was proven to be an effective prophylactic bronchial stump method for post-resection BPF in the pediatric population over short and mid-term follow-up.

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