

Original Research Article

Efficacy of homologous fibrin sealant in the surgery for pneumothorax

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ABSTRACT

Background: Prolonged air leakage following pneumothorax surgery is a significant issue causing increased hospital stay and morbidity. This study aimed to investigate the cost and efficacy of homologous fibrin sealant in preventing the air leakages.

Methods: Among the patients who had undergone bullectomy and subtotal parietal pleurectomy for recurrent primary spontaneous pneumothorax via transaxillary mini thoracotomy between 2010 and 2018, two groups each including 35 cases were conducted as to whether fibrin sealant had been applied. These two patient groups were compared in terms of age, gender, duration of air leakage and cost.

Results: Mean age of whole group of patients including 59 males and 11 females was 21.5 years. Mean values of air leakage duration and cost of hospital stay was calculated as 1.94 days and 2777 TL for sealant applied group and 2.97 days and 1200 TL for sealant unapplied group, respectively. The patient groups did not indicate a statistically difference in terms of age and gender whereas duration of air leakage was shorter but cost was higher in the group for whom fibrin sealant had been administered ($p < 0.001$). None of the patients developed mortality but recurrence was present in 4 (5.7%) patients.

Conclusions: Although homologous fibrin sealant applied in pneumothorax surgery results in cost increase, it contributes to surgical outcomes by preventing possible additional complications in consideration of shortened duration of air leakage.

Keywords: Complication, Cost, Homologous fibrin sealant, Spontaneous pneumothorax, Thoracotomy

INTRODUCTION

Primary spontaneous pneumothorax (PSP) occurs in patients without any underlying pulmonary diseases and is frequently induced by the rupture of subpleural blebs and bullae.

Conservative treatment or tube thoracostomy is usually adequate in the first episode of pneumothorax whereas recurrent pneumothorax, persistent air leakage or expansion defect of the lung parenchyma following chest tube insertion and bilateral pneumothorax are considered as principal indications for surgery.¹

Surgical approaches are represented by conventional thoracotomy and video-assisted thoracoscopic surgery (VATS) where both of the techniques depend on the idea of removing the deformed parenchymal tissue and preventing the deflation of the lungs.²

The main complications of a pneumothorax surgery are prolonged air leakage and inadequate expansion of the lung parenchyma both causing increased rates of morbidity and longer hospital stay.

Aim of this study was to compare the outcomes of homologous fibrin sealant (HFS) utilization in terms of

complications, duration of postoperative air leakage, recurrence and cost effectiveness.

METHODS

The patients with second-episode PSP who had undergone transaxillary mini thoracotomy (TMT) between 2010 and 2018 were retrospectively analyzed. Exclusion criteria were the diagnosis of secondary spontaneous pneumothorax and the incompatibility with the scheduled postoperative follow-ups.

Operations including wedge resections or bullectomy in addition to partial parietal pleurectomy were applied by the same two surgeons through a standardized 10 cm axillary incision sparing the serratus anterior muscle. A single kit of HFS was administered covering the parenchymal resection line entirely and the lung was fully inflated for 2 minutes. Pleurodesis was not applied in any of the cases. At the end of operations, a single 24-French chest tube was placed into the thoracic cavity. Radiological screening was conducted beginning at postoperative day one and ending the day after the chest tube was pulled out. Patients were invited to follow-up examinations during the first and third weeks after being discharged. Recurrence was accepted to be present when it was confirmed radiologically during the first three week follow-ups and recognized on the same side of initial operation.

A total of 70 patients with equal numbers for two groups considering the administration of HFS were examined in terms of age, gender, duration of postoperative air leakage, complications, status of recurrence and expenditures. Total cost was calculated by reviewing the

records for each patient including the expenditures of hospital stay and surgical instruments.

SPSS (IBM SPSS for Windows, ver.24) statistical package program was used for calculations. Descriptive statistics for continuous variables in the study were expressed as mean, standard deviation, minimum and maximum; categorical variables were expressed as number (n) and percentage (%). Independent t-test was used to compare average of measurements for patient groups and Chi-square test was employed to reveal the relation between categorical variables. p values <0.05 were considered statistically significant.

RESULTS

A total of 70 patients included 59 (84.3%) males and 11 (15.7%) females. Mean age was 21.5 ± 3.16 (range=18-26) years. Mean duration of postoperative air leakage was 2.46 ± 0.56 (range=1-4) days. Average of costs was 1983 ± 417.3 (range=800-3200) TL. Recurrence of pneumothorax occurred in 4 (5.7%) patients (Table 1).

Table 1: Demographic and clinical features of the patients.

Gender (n) (%)	Male	59 (84.3%)
	Female	11 (15.7%)
Age (mean±SD/ range) (years)	21.5±3.16/ 18-26	
Air Leakage (mean±SD/ range) (days)	2.46±0.56/ 1-4	
Recurrence (n) (%)	4 (5.7%)	
Cost (mean±SD/ range) (TL)	1983±417.3/ 800-3200	

Table 2: Comparison of fibrin sealant administration.

Parameters	Fibrin sealant administration		Total	p-Value
	None	Yes		
Gender (Male/ Female) (n)	30/5	29/6	59/11	0.751
Age (mean±SD) (years)	21.6±2.5	21.4±2.3	21.5±3.16	0.766
Air Leakage (mean±SD) (days)	2.97±0.5	1.94±0.9	2.46±0.56	<0.001
Recurrence (n)	2.0	2.0	4.0	1
Cost (mean±SD) (TL)	1200±573	2777±463	1983±417.3	<0.001

Group of 35 patients for whom HFS was applied included 29 (82.9%) males and 6 (17.1%) females whereas 30 (85.7%) males and 5 (14.3%) females established the group of cases who did not receive HFS administration. Mean age was 21.4 ± 2.3 and 21.6 ± 2.5 years for HFS applied and not applied groups of patients, respectively.

Average duration of postoperative air leakage was calculated as 1.94 ± 0.9 days for the cases who had been treated with HFS and 2.97 ± 0.5 days for the rest of the

patients. Two patients from each groups developed recurrence during the the follow-ups. Mean cost was 2777 ± 463 TL for HFS group and 1200 ± 573 TL for the patients who had not received HFS. The difference between cohorts of patients in terms of age, gender or rate of recurrence was not statistically significant while cases who had undertaken HFS administration demonstrated shorter duration of air leakage but higher cost of treatment ($p < 0.001$). None of the patients developed mortality or morbidity (Table 2).

DISCUSSION

The findings of this study clearly show that administration of HFS in the surgical treatment of pneumothorax avails the reduction of postoperative air leakage causing acceptable incremental costs.

Fibrin sealant is a two-component system including concentrated fibrinogen and factor XIII that is combined with a solution of thrombin and calcium to form a coagulum. It is applied using a two-syringe system in the operating room. Since fibrinogen concentrations in fibrin sealants are higher than physiologic concentrations at the site of bleeding, a fibrin clot forms much faster than the native coagulation process.³

Bergel was the first to apply fibrin emulsion to improve wound healing in 1909. In 1944, the combination of thrombin and fibrinogen was introduced to enhance the adhesion of skin grafts in patients with severe burn injuries. Matras reported the efficiency of a fibrin sealant for peripheral nerve repair in rabbits in 1972. Since The Food and Drug Administration (FDA) approved the licensing in 1998, fibrin sealants have been administered for hemostasis, wound closure and tissue sealing. The first commercially available fibrin sealants were Tisseel (Immuno AG, Vienna, Austria) and Beriplast (Behringwerke, Marburg, Germany).^{3,4}

Range of fibrin sealant applications varies widely including intraocular lens fixation, sealing scleral patch grafts or fistula for glaucoma, corneal perforation, removing conjunctival redundancy in ophthalmology, hernia repair, intraoperative air leak prevention, treatment of chylothorax and tracheo-bronchial injury in thoracic surgery, fistula closure, hemostasis in hepatic surgery, dural closure in neurosurgery, orthopedic joint repair, external coating of colonic and gastric anastomoses in gastrointestinal surgery, hemostasis in nephrolithotomy, periodontal flap closure in dental surgery and covering linear stapled gastrojejunostomy in bariatric surgery.⁵⁻¹¹

Although application of fibrin sealants is accepted to be safe considering that reabsorption of the fibrin clot is achieved during normal wound healing preventing inflammation, foreign body reactions or tissue necrosis, a few number of documents reporting fibrin sealant related air embolism, hypotension, surgical infection, poor wound healing, blood-borne diseases, immune-mediated coagulopathy and anaphylaxis are available.^{4-6,10,11}

The use of fibrin sealant to control pulmonary air leakage remains controversial mainly resulting from numerous differences in the recent studies: the type of sealant used, the application technique, the operation performed and the reason of air leakage as the lung parenchyma or the bronchial stump.¹²

The application of fibrin sealants was reported to be efficient in reducing the duration of air leaks without any

major complications whereas Kilic et al, compared autologous and heterologous fibrin sealants in patients who had undergone lung resections and concluded that both were safe and acted similarly in terms of air leaks and hospital stay.^{13-16,17} Also, an experimental model of partial pulmonary resection and lung incision in rabbits proved that fibrin sealants and cyanoacrylate glues had an equal effect of airtight sealing but fibrin sealants demonstrated superiority for the prevention of bronchopleural fistulas and air leaks due to biocompatibility.¹⁸

Moser et al, applied fibrin sealant for the reinforcement of the staple lines after lung volume reduction surgery to reduce prolonged air leaks successfully.¹⁹ On the contrary, Kumbasar et al, announced that removal time of chest tubes, total drainage amount and intensive care unit stay time were similar in two patient groups depending on fibrin sealant application and sealants might be helpful particularly in small air leakages.²⁰ In this series limited by number of cases and single type of lung surgery, fibrin sealant was effective in reducing the air leaks by coating the staple or suture lines over the resected lung parenchyma.

CONCLUSION

In conclusion, application of homologous fibrin sealant in pneumothorax surgery is a safe procedure to reduce the duration of air leaks. Slightly elevated costs may be accepted to be tolerable considering the decreased morbidity and hospital stay time.

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