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ORIGINAL ARTICLE

Frequency and Risk Factors of Bronchopleural Fistula in Tube Thoracostomy Patients

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ABSTRACT

Objective: To determine the frequency of Bronchopleural Fistula (BPF) in patients underwent tube thoracostomy (TT), and associated risk factors in BPF.

Methods: A descriptive observational research was conducted at Chest Units of Ojha Institute of Chest Diseases, Dow University of Health Sciences (DUHS) Karachi from September 2018 to February 2019 on 125 patients selected by consecutive sampling method. Patients underwent for tube thoracostomy were included in the study, whereas children (age < 13 years), pregnant women or patients diagnosed with multiloculated empyema or multiloculated pleural effusion were excluded from the study. BPF was diagnosed based on continuous air leak for > 72 hours.

Results: Out of 125 patients underwent for TT, BPF was detected in 38 (30.4%) patients. Out of which 28 (73.7%) patients were male, and 10 (26.3%) were female. BPF was classified into continuous 17 (44.7%), expiratory 13 (34.2%), force expiratory 4 (10.4%) and inspiratory 4 (10.4%) patients. The odds of BPF was 4.65 times higher among individuals with diabetes mellitus (AOR: 4.65, 95% CI: 1.14-18.95), 2.17 times higher among individuals with COPD (AOR: 2.17, 95% CI: 0.45-10.42), 2.80 times higher among individuals with TB (AOR: 2.80, 95% CI: 1.09-7.22), 2.74 times higher among individuals with empyema (AOR: 2.74, 95% CI: 0.96-7.83), 2.49 times higher among individuals with smoking (AOR: 2.49, 95% CI: 0.95-6.49), while individuals with malignancy were 90% less likely to have BPF (AOR: 0.10, 95% CI: 0.01-0.99).

Conclusion: The research concludes that prevalence of bronchopleural fistula is high among tube thoracostomy patients, and risk factors such as DM, COPD, TB, and non-malignant are significantly associated with BPF.

Keywords: Bronchopleural fistula, tube thoracostomy, empyema, pleural effusion.

INTRODUCTION

Nowadays, in chest and emergency departments most frequently performed surgical procedure is tube thoracostomy (TT). The surgical procedure is either used in emergency in operating rooms or electively at bedside to drain out the pleural accumulations. [1] TT or chest tubes are silicone or polyvinyl chloride (PVC) flexible tubes inserted through chest wall, crossed the ribs, and placed in pleural space. After appropriate placement of chest tube, distal end is connected with pleura-evac system, that helps in removal of pleural collection. [1, 2] TT system works on a simple phenomenon i.e., chest tubes generate the negative pressure after insertion in chest cavity that helps in removal of different types of collections from pleural space such as fluid, air, bile, chyle, or blood, etc. [3]

It is an invasive surgical procedure performed in various clinical conditions such as chest trauma (penetrated or severe blunt), pleural effusion, hydrothorax, hemothorax, pneumothorax, hemopneumothorax, chylothorax, empyema, bronchopleural fistula (BPF), or post-operatively in cardiac or thoracic surgery, etc. [4-6] Although tube thoracostomy is among the life-saving procedures but misfortunately also directly associated with life-threatening clinical problems such as; injury of lung, diaphragm, esophageal, cardiac vessel, thoracic duct, or abdominal organs, BPF, infection at chest wall or chest tube site, empyema, emphysema, arteriovenous fistula, pain, failure to place tube or tube occlusion, kinking or dislodgment, etc. Prevalence of complications after TT is < 10.0%, depending upon the experience of physician, chest tube size, and use of imaging technique for

insertion of chest tube. [7-9]

BPF is rare abnormal communication between pleural space and bronchus or airways, mostly reported in patients underwent for TT, as well as because of chest trauma (penetrated or severe blunt), pulmonary infection, lung neoplasm, empyema, or complication of surgical procedures such as during lung biopsy, or chemotherapy or radiation therapy, etc. [10-12] Even though BPF is a rare complication but its diagnosis and management is challenge for Physicians, [13] that raises its morbidity (25-71%), [14] and mortality (16-72%). [15] Increasing age > 60 years, diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), tuberculosis (TB), empyema, heavy smoking, steroid drug use, malignancy, and right side are some common risk factors associated with BPF. [10,16]

Current research was focused on determination of magnitude of BPF in patients underwent for TT as well as on associated risk factors in BPF. It is very important aspect of the study that no such type of studies has been conducted throughout the Pakistan. Therefore, study helps in determination of current frequency of BPF in local population of Pakistan as well as identify the modifiable risk factors playing role in developing BPF, so the measures will be taken prior to development of BPF.

METHODS

A descriptive observational research was conducted at Chest Units of Ojha Institute of Chest Diseases, Dow University Hospital Sciences (DUHS) Karachi from September 2018 to February 2019. Total of 125 patients were selected by consecutive sampling method. Patients underwent for tube thoracostomy were included in the study, whereas children (age < 13 years), pregnant women or patients diagnosed with multiloculated empyema or multiloculated pleural effusion were excluded from the study. Research and ethical approval were obtained from the institutional review board (IRB), and board of advanced studies and research (BASR) of DUHS Karachi (IRB #: 1039/DUHS /Approval/2018/88). Detailed medical history of each patient was obtained, and clinical examination of each patient was performed before and after TT for evaluation of BPF. BPF was diagnosed on the basis of continuous air leak for > 72 hours and classified into forced expiratory (continuous air leak and presence of cough), expiratory (continuous air leak on expiration), inspiratory (continuous air leak on inspiration), and continuous (continuous air leak on both inspiration and expiration). Sample size was calculated by using the following formula;

$$n = \frac{Z^2 \; X \; P\,(100 - P)}{d^2}$$

where reported BPF prevalence (P) 20.0% by Cerfolio RJ, et al. [17] confidence interval (CI) 95% =1.96, and margin of error (d) 7%, resulting sample size 125.

A written informed consent was obtained from each patient after explaining the surgical procedure to patient. Aseptic measures and aseptic surgical instruments were used for TT. Patient was positioned on bed at 45°, axillary area was exposed by raising arm behind the head. Exposed area of skin was cleaned with antiseptic solution and local anesthesia lignocaine (3 mg/kg) was applied. Chest tube of size 24-28 FR was used for pleural effusion and pneumothorax, and 32 FR for empyema. An open small incision with surgical blade was given and dissection of deep tissue was done with artery forceps, followed by insertion of chest tube at appropriate place with care to avoid any injury or complication. All holes of chest tube were kept in pleural cavity and then connected with closed drainage system that works effectively. After that incision on skin was closed with 2-0 silk suture on each side, and aseptic dressing was done at incision site.

All the collected data were analyzed by using SPSS version 22. Chi-square test was applied to assess significant association between various qualitative variables and outcome variable (BPF). Univariate binary-logistic regression was also applied to assess significant association between various qualitative variables and outcome variable (BPF). P-value < 0.05 was considered significant. All the variables with P-value ≤ 0.05 in univariate analysis were selected

for multiple logistic regression (LR) to calculate Adjusted Odds Ratio. Backward LR method was applied to develop the final model.

RESULTS

During the study period 125 patients underwent for TT were observed, out of which 88 (70.4%) were male and 37 (29.6%) were female with mean age of 40.07 ± 18.29.

Before performing TT, each patient was evaluated for different risk factors of BPF, and results were summarized as; age > 60 years 16 (12.8%), DM 16 (12.8%), COPD 12 (9.6%), TB 36 (28.8%), empyema 25 (20.0%), smoking 35 (28.0%), steroid drug use 4 (3.2%), malignancy 19 (15.2%), and right affected site in 66 (52.8%) patients.

After TT, pleural effusion was diagnosed in 45 (36.0%) patients, followed by pneumothorax 34 (27.2%), empyema 19 (15.2%), pyonpneu mothorax 18 (14.4%), hydropn eumothorax 7 (5.6%), and chylothorax 1 (0.8%), and hemothorax in 1 (0.8%). Majority of the patients were extubated 89 (69.6%), followed by conservatively management and extubation 27 (21.6%), whereas 11 (8.8%) were referred to thoracic surgeon for management.

BPF was observed in 38 (30.4%) patients underwent for TT, out of which continuous BPF was observed in 17 (44.7%), followed by expiratory BPF in 13 (34.2%), force expiratory 4 (10.4%), and inspiratory 4 (10.4%). (Figure 1) BPF was significantly associated with DM (p=0.003), COPD (p=0.004), TB (p=0.001), empyema (p=0.03), smoking (p=0.006), steroid use (p=0.04), malignancy (p=0.01), and management of TT (p=0.001), whereas non-significantly associated with gender (p=0.5), age > 60 years (p=0.2), and affected site (p=0.6) (table 1).

Univariate analysis revealed that the odds of BPF was 4.82 times higher among individuals with diabetes mellitus (OR: 4.82, 95% CI: 1.61-14.48), 5.53 times higher among individuals with COPD (OR: 5.53, 95% CI: 1.55-19.72), 2.89 times higher among individuals with TB (OR: 2.89, 95% CI: 1.28-6.56), 2.63 times higher among individuals with empyema (OR: 2.63, 95% CI: 1.07-6.48), 3.10 times higher among individuals with smoking (OR: 3.10, 95% CI: 1.36-7.07), while individuals with malignancy were 90% less likely to have BPF (OR: 0.10, 95% CI: 0.01-0.81). Similar findings were observed with multivariate analysis as well. After adjusting for other covariates, the odds of BPF was 4.65 times higher among individuals with diabetes mellitus (AOR: 4.65, 95% CI: 1.14-18.95), 2.17 times higher among individuals with COPD (AOR: 2.17, 95% CI: 0.45-10.42), 2.80 times higher among individuals with TB (AOR: 2.80, 95% CI: 1.09-7.22), 2.74 times higher among individuals with empyema (AOR: 2.74, 95% CI: 0.96-7.83), 2.49 times higher among individuals with smoking (AOR: 2.49, 95% CI: 0.95-6.49), while individuals with malignancy were 90% less likely to have BPF (AOR: 0.10, 95% CI: 0.01-0.99). (Table 2)

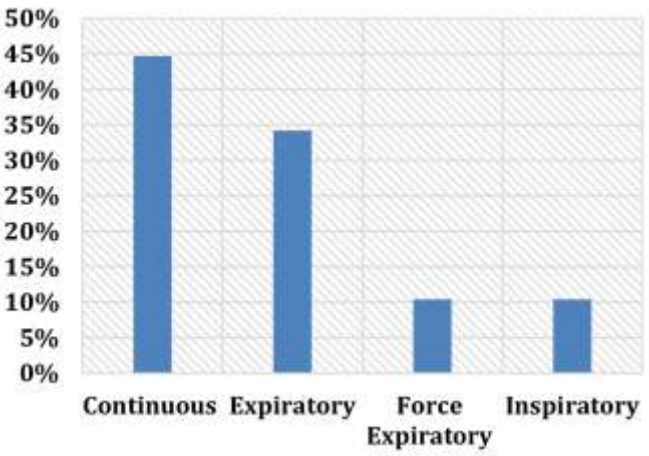

Figure 1: Grading of Bronchopleural Fistula in patients with Tube thoracostomy (n=38)

DISCUSSION

Tube thoracostomy is most commonly performed in chest and emergency departments that requires the expertise to lower down the rate of complications and perform the surgical procedure safely and effectively. [18, 19] Rate of complications of TT is directly associated with TT method, that's why use of trocar technique is prohibited in many clinics. [18, 20] BPF is rare pulmonary complication of TT but its diagnosis and management is very difficult that increases the chances of morbidity, mortality as well as hospital stay and expenditure on health. It is very interesting to know that, on one side TT is

Table 1: Comparison of BPF with risk factors and baseline characteristics (n=145)

Variables	BPF		Total (n=125)	P-value
	Yes (n=38)	No (n=87)		
Gender				
Male	28 (73.7%)	60 (69.0%)	88 (70.4%)	0.50
Female	10 (26.3%)	27 (31.0%)	37 (29.6%)	
Age (Years)				
< 60	35 (92.1%)	74 (85.1%)	109 (87.2%)	0.20
> 60	3 (7.9%)	13 (14.9%)	16 (12.8%)	
DM				
Yes	10 (26.3%)	6 (6.9%)	16 (12.8%)	0.002
No	28 (73.7%)	81 (93.1%)	109 (87.2%)	
COPD				
Yes	8 (21.1%)	4 (4.6%)	12 (9.6%)	0.004
No	30 (78.9%)	83 (95.4%)	113 (90.4%)	
TB				
Yes	17 (44.7%)	23 (26.4%)	36 (28.8%)	0.001
No	21 (55.3%)	64 (73.6%)	89 (71.2%)	
Empyema				
Yes	12 (31.6%)	13 (14.9%)	25 (20.0%)	0.03
No	26 (68.4%)	74 (85.1%)	100 (80.0%)	
Smoking				
Yes	17 (44.7%)	18 (20.7%)	35 (28.0%)	0.005
No	21 (55.3%)	69 (79.3%)	90 (72.0%)	
Steroid use				
Yes	3 (7.9%%)	1 (1.1%)	4 (3.2%)	0.04
No	35 (92.1%)	86 (98.9%)	121 (96.8%)	
Malignancy				
Yes	1 (2.6%)	18 (20.7%)	19 (15.2%)	0.01
No	37 (97.4%)	69 (79.3%)	106 (84.8%)	
Management				
CM&Ex.*	27 (71.1%)	0 (0.0%)	27 (21.6%)	0.001
Ref. TC*	11 (28.9%)	0 (0.0%)	11 (8.8%)	
Extubated	0 (0.0%)	87 (100.0%)	87 (69.6%)	
Site				
Left	16 (42.1%)	42 (48.3%)	58 (46.4%)	0.60
Right	22 (57.9%)	44 (50.6%)	66 (52.8%)	
Bilateral	0 (0.0%)	1 (1.1%)	1 (0.8%)	

*CM & Ex.: Conservatively managed and extubated.

*Ref. TC.: Referred to Thoracic surgeon

Table 2: Regression analysis of the variables associated with Bronchopleural Fistula (n=125)

Variables	Univariate		Multivariate	
	OR (n=38)	95% CI	AOR	95% CI
DM				
Yes	4.82	1.61-14.48	4.65	1.14-18.95
No	Ref		Ref	
COPD				
Yes	5.53	1.55-19.72	2.17	0.45-10.42
No	Ref		Ref	
TB				
Yes	2.89	1.28-6.56	2.80	1.09-7.22
No	Ref		Ref	
Empyema				
Yes	2.63	1.07-6.48	2.74	0.96-7.83
No	Ref		Ref	
Smoking				
Yes	3.10	1.36-7.07	2.49	0.95-6.49
No	Ref		Ref	
Malignancy				
Yes	0.10	0.01-0.81	0.10	0.01-0.99
No	Ref		Ref	

BPF: Bronchopleural Fistula, TB: Tuberculosis, DM: Diabetes Mellitus, COPD: Chronic Obstructive pulmonary disease
OR: Odds Ratio, AOR: Adjusted Odds Ratio

responsible for development of BPF, whereas on other side TT is used for management of existing BPF. BPF associated with TT may results in failure of chest drainage. Therefore, alternative techniques or interventions such as antibiotic administration, nutritional support, or surgical or bronchoscopic closure can be implemented for management of BPF. [21-23]

Development of BPF in TT patients is least focused Internationally as well as locally and only very few studies have been conducted throughout the world. Therefore, the current reseach was designed and conducted on admitted patients at chest unit, OJHA campus DUHS Karachi. The focus of research was on TT patients, so that current magnitude of BPF in TT patients can be determined along with associated risk factors for development of BPF.

The current research determines that majority of the male 88 (70.4%) patients were underwent for TT with high mean age 41.30 ± 19.35 years as compared to females 37 (29.6%) with low mean age 37.16 ±15.32 years. Similarly, BPF was detected in 38 (30.4%) patients among which majority of the patients were male 28 (73.7%). Previous research studies also reported the similar results that male patients are more affected with diseases that leads towards TT such as Hashmi U, et al reported the 74.1% male, [1] Tatar C, et al. reported the 92% male, [4] Nachira D, et al. reported the 65.4% male, [14] and Okuda M, et al. 65.5% male. [16] All studies are reporting that male patients are commonly affected with diseases that requires TT.

The current research reported the higher prevalence 38 (30.4%) of BPF as compared to previous studies, Mazzella A, et al. (8.2%), [12] Nachira D, et al. (2.6%), [14] Okuda M, (1.8%), [16] Cerfolio RJ, et al. (20%), [17] and Dural K, et al. (5.5%). [18] The rate of BPF was high because of

several reasons such as lack of experience, lack of facilities, poor hygienic conditions, improper sterilization of surgical instruments, and presence of high prevalence of comorbidities such as DM, COPD, TB, empyema, heavy smoking, malignancy, and steroid drug use.

The current research reported the significant relation of BPF and above-mentioned risk factors, similarly previous studies also determined the similar risk factors that are playing vital role in development of BPF. [12, 16] Empyema and smoking were the only variables found non-significant in multivariable analysis in this study.

The current research also reported that in BPF patients right side 22 (57.9%) was mostly affected than left side 16 (42.1%), whereas diagnosis in patients was pleural effusion 45 (36.0%), pneumothorax 34 (27.2%), empyema 19 (15.2%), pyonpneumothorax 18 (14.4%), and hydropneumothorax 7 (5.6%), Similar results were also reported by Mazzella A, et al., [12] Okuda M, et al., [16] and Dural K, et al. [18]

Our research findings are very important in view of small sample size, along with data collected from only one hospital. Such type of studies requires multicentre with large sample size in order to obtain the accurate magnitude of BPF in tube thoracostomy patients along with associated risk factors responsible for development of BPF.

CONCLUSION

The research concludes that prevalence of bronchopleural fistula is high among tube thoracostomy patients, and risk factors such as DM, COPD, TB, and non-malignant are significantly associated with BPF. Further studies are needed in order to consolidate the current results in multicenter studies and a scoring system could be devised to predict the occurrence of BPF.

AUTHORS' CONTRIBUTION: SKA, FFZ substantially contributed to the conception and design of the study. SKA worked in the acquisition, analysis, and interpretation of data, FFZ, SH drafted the manuscript, FFZ revised it critically for important intellectual content gave the final approval of the manuscript.

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