Original Paper

Role of Continuous Low Pressure Suction in Management of Traumatic Haemothorax and/or Haemopneumothorax: Experiences at NIDCH and CMH Dhaka

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Abstract

Introduction: The number of chest trauma patients has rapidly increased in this 21st century of high speed travel, violence, natural and manmade disasters. Most of the patients present with haemothorax and/or haemopneumothorax. Drainage of haemothorax and/or haemopnumothorax by tube thoracostomy is the main stay of treatment. Even timely insertion of chest tube sometimes fails to drain haemothorax adequately and results in clotted haemothorax for which surgical management is needed. Application of continuous low pressure suction through chest tube hastens evacuation of blood and reduces incidence of clotted haemothorax and thoracotomy.

Objective: The aim of this study is to find out the effectiveness of continuous low pressure suction in evacuation of blood and air from pleural cavity, in early re-expansion of lung and reduction of clotted haemothorax in comparison with simple chest tube drainage.

Methods: This randomized controlled clinical trial was conducted at Combined Military Hospital (CMH) Dhaka and National Institute of Diseases of the Chest and Hospital (NIDCH), Mohakali, Dhaka from April 2012 to March 2013. A total of 60 patients with blunt and penetrating chest trauma fulfilling the selection criteria enrolled in this study. Patients were allocated into two groups. Patients who received continuous low pressure suction on their chest tubes were leveled as group-I and patients who received only chest tube drainage were leveled as group-II. Data were collected by interview, observation, clinical examination and investigation results. Data were processed and analyzed by using statistical test.

Results: The mean chest tube duration was 7.13±2.1 days with a range from 5-16 days in group-I as compared to 11.83±5.26 days with a range from 6-28 days in group-II. The mean duration of hospital stay was 8.97±2.28 days with a range from 6-18 days in group-I as opposed to 13.47±5.53 days with a range from 8-32 days in group-II. In group-I 96.7% patients achieved full lung re-expansion while 3.3% patients had clotted haemothorax for which they underwent thoracotomy and evacuation of clot. In group-II who was on simple chest tube drainage, 76.7% patients achieved full lung re-expansion and 23.3% patient had clotted haemothorax and required thoracotomy.

Conclusion: Continuous low pressure suction is a useful device in the management of traumatic haemothorax and/or haemopneumothorax. It reduces morbidity, hospital stay and cost of thoracic surgery.

Key-words: Continuous low pressure suction, traumatic haemothorax, chest tube.

Introduction

In present situation of increasing violence and Road Traffic Accident (RTA) chest trauma is common in anywhere in the world. Today death resulting from chest trauma ranks third after cancer and cardiovascular diseases[1]. The worldwide implementation of standardized diagnostic and therapeutic guidelines, such as the "Advanced Trauma Life Support" (ATLS) protocol, has led to a significant reduction of early deaths attributed to thoracic injuries[2]. Despite improvement in ambulance service and rapid mobilization of victims from the scene of

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accident, about 10% of chest injury patients die on the spot and another 5% die within an hour of reaching the hospital. Of the remaining 85%, five percent will require emergency thoracotomy for various reasons while 80% will respond to resuscitative measures and tube thoracostomy drainage alone[3]. Significant number of chest trauma patients present with heamothorax. Chest tube placement is the mainstay of the management of traumatic haemothorax[4]. Failure to drain a haemothorax adequately by chest tube, results in clotted haemothorax. It will not drain via a chest tube. If left untreated, these retained haemothorax may become infected and lead to empyema formation[5]. Even if remain uninfected, the colt will organize and fibroses, resulting in a loss of lung volume and impaired pulmonary function[6]. Diagnosis of clotted haemothorax is usually made on Computed Tomography (CT) scan. Surgery is indicated if there is evidence of clotted haemothorax[7]. If clot evacuation is delayed beyond this time, the inflammatory reaction in the pleura requires a more formal thoracotomy and decortication- a much longer and bloodier procedure associated with increased incidence of morbidity, hospital stay and cost[8].

Many studies have been conducted to assess effectiveness of continuous low pressure suction in evacuation of blood and air in patients with chest trauma, inflammatory diseases of lung and pleura and post-operative patients. In this regard, there exits two school of thought. One group favors application of continuous low pressure suction to the chest tubes arguing that it expedites the evacuation of blood and air and expansion of lung and thereby shortens the time to removal of chest drain. The others argue that continuous low pressure suction to the chest tube affect the recovery process and increase the hospital stay and cost[9]. The present study was undertaken to assess the effectiveness of continuous low pressure suction in evacuation of blood and air from pleural cavity and in early re-expansion of lung by comparing with simple chest tube drainage.

Materials and Methods

This randomized controlled clinical trial was conducted at the thoracic surgery department of Combined Military Hospital (CMH) Dhaka and National Institute of Diseases of the Chest and Hospital (NIDCH), Mohakhali, Dhaka over a period of one year starting from April 2012 to March 2013. Patients with blunt and penetrating chest trauma were included in study population subject to fulfilling the selection criteria.

Patient's selection criteria:

Inclusion criteria:

- Patients with blunt and penetrating chest trauma of any age and either sex clinically & radiologically diagnosed as haemothorax and/or haemopneumothorax.
- Patients were admitted within 48 hours of trauma.
- Patients with traumatic haemothorax and/ or haemopneumothorax with or without rib fracture.

Exclusion criteria:

- Patients with traumatic haemothorax and/or haemopneumothorax with bronchoplural fistula.
- Patients with persistent active bleeding i.e 300ml/hour for three consecutive hours.
- Patients with traumatic haemothorax and/ or haemopneumothorax whose initial drainage through chest tube was ≥ 1500 ml.
- Patients with traumatic haemothorax and/ or haemopneumothorax assocaited with intra abdominal injury or severe head injury.
- Patients admitted after 48 hours of injury.

A total of 60 patients fulfilling the above selection criteria were enrolled in this study. Patients were allocated into two groups. Odd numbers were included in group-I and even numbers were included in group-II.

Group-I: Continuous low pressure suction applied with outlet of water seal drainage system.

Group-II: Without continuous low pressure suction, i.e. only chest tube drainage connected with water seal drainage system.

Suction protocol: Continuous low pressure suction ranged from -05 to -20 cm of water was applied to water seal bottle outlet. It was continuously (24 hours a day) applied and only interrupted at the time of bottle change or patient going to wash rooms (less than 20 minutes at one time). Prior to commencement of the study, patients were explained

about the study design, the purpose of the study and informed written consent was obtained. A structured data collection form was developed containing all pre tube thoracostomy and post tube thoracostomy variables of interest. Data were collected by interview, observation, clinical examination and investigation results. Data were processed and analyzed using SPSS (Statistical package for social science) Version 16. Data was expressed as mean±SD and percentage according to type of variables used. The statistical test used to analyze the data were student's t-test (Unpaired t-test) and chi-square (x^2) test. For all analytical tests, the levels of significance were set at 0.05 and $p<0.05$ was considered significant. The summarized data were presented in the form of tables.

Results

Total 60 patients were included in the study and allocated into two groups. Patient's pre tube thoracostomy variables such as age, sex, clinical presentation, types of trauma, cause of trauma, treatment and post tube thoracostomy variables such as chest tube drainage, chest tube duration, thoracotomy, hospital stay in both groups were recorded and compared.

Table-I shows age distribution of study patients and compared with group-I and group-II. Highest numbers of patients in both groups were belonged to 21-30 years age group. They were 36.7% and 30% of their representative group respectively. Mean age of group-I was 36.73±12.88 years and group-II was 40.97±14.45 years. No statistical significant difference was observed in terms of age between two groups (P>0.05).

Table-I: Comparison of age distribution between groups.

Age (years)	Group-I (n=30)		Group-II (n=30)		*P* Value
	n	%	n	%	
≤20	1	3.3	2	6.7	
21-30	11	36.7	9	30.0	
31-40	8	26.7	5	16.7	
41-50	6	20.0	6	20.0	
51-60	3	10.0	5	16.7	
>60	1	3.3	3	10.0	
Mean±SD	36.73±12.88		40.97±14.45		0.235^{ns}
Range	10-65		18-70		

^{ns}= not significant
P value reached from unpaired t-test

Table-II shows distribution of sex of the study patients and compared with group-I and group-II. Majority patients of both groups were male. 76.7% patients in group-I were male compared to 83.3% in group-II. On the other hand, 23.3% patients in group-I were female compared to 16.7% in group-II. Male to female ratio in group-I was 3.5:1 and in group-II was 3.8:1. The difference was not statistically significant (P>0.05).

Table-II: Comparison of sex distribution between groups.

Sex	Group-I (n=30)		Group-II (n=30)		*P* Value
	n	%	n	%	
Male	23	76.7	25	83.3	0.518^{ns}
Female	7	23.3	5	16.7	

^{ns}=not significant
P value calculated from chi-square test

Table-III demonstrates distribution of types of trauma. Blunt trauma was sustained by 76.7% patients in group-I and 56.7% patients in group-II. 23.3% patients in group-I sustained penetrating trauma as compared to 43.3% in group-II. Regarding blunt and penetrating chest trauma the difference was not statistically significant between two groups (P>0.05).

Table-III: Comparison of types of trauma between groups.

Made of Trauma		Group-I (n=30)		Group-II (n=30)		*P* Value
		n	%	n	%	
Blunt Trauma	Yes	23	76.7	17	56.7	0.100^{ns}
	No	7	23.3	13	43.3	
Penetrating Trauma	Yes	7	23.3	13	43.3	0.100^{ns}
	No	23	76.7	17	56.7	

^{ns}=not significant
P value calculated from chi-square test.

Table-IV depicts causes of trauma among the study patients. RTA was 50.0% in group-I and 40% in group-II. Stab injury was 26.7% in group-I and 33.3% in group-II. Fall from height was 20.0% and 16.7% in group-I and group-II respectively. Gunshot injury was 3.3% in group-I and 10.0% in group-II. The difference was not statistically significant between group-I and group-II (P>0.05).

Table-IV: Comparison of causes of trauma between groups.

Cause of Trauma		Group-I (n=30)		Group-II (n=30)		*P* Value
		n	%	n	%	
RTA	Yes	15	50.0	12	40.0	0.436^{ns}
	No	15	50.0	18	60.0	
Stab injury	Yes	8	26.7	10	33.3	0.573^{ns}
	No	22	73.3	20	66.7	
Fall from height	Yes	6	20.0	5	16.7	0.738^{ns}
	No	24	80.0	25	83.3	
Gunshot injury	Yes	1	3.3	3	10.0	0.305^{ns}
	No	29	96.7	27	90.0	

^{ns}=not significant
P value calculated from chi-square test.

Table-V depicts post tube thoracostomy X-ray chest findings of study subjects. 96.7% patients of group-I achieved full lung expansion as opposed to 76.7% in group-II in last follow up x-ray chest after tube thoracostomy. 3.3% patients of group-I had radiological evidence of partial lung expansion whereas it was 23.3% in group-II. Significant statistical difference was observed in full lung expansion and partial lung expansion between two groups (P<0.05).

Table-V: Comparison of X-ray chest findings (Post tube thoracostomoy) between groups.

X-ray Chest Findings		Group-I (n=30)		Group-II (n=30)		*P* Value
		n	%	n	%	
Immediately after IT tube	Full Lung Expansion	24	80.0	19	66.3	0.145^{ns}
	Partial Lung Expansion	6	20.3	11	36.7	
During Follow up (1st)	Full Lung Expansion	26	86.7	21	70.0	0.185^{ns}
	Partial Lung Expansion	4	13.3	9	30.0	
During Follow up (Last)	Full Lung Expansion	29	96.7	23	76.7	0.026^{s}
	Partial Lung Expansion	1	3.3	7	23.3	
After removal of chest tube	Full Lung Expansion	30	100.0	28	93.3	0.245^{ns}
	Partial Lung Expansion	0	0	2	6.7	

^{s}=significant; ^{ns}=not significant
P value calculated from chi-square test.

Table-VI depicts post tube thoracostomy CT scan of chest findings of study subjects. 96.7% patients of group-I achieved full lung expansion as opposed to 76.7% in group-II. 3.3% patients of group-I had evidence of clotted haemothorax whereas it was 23.3% in group-II. 6.7% patients in group-I had evidence of consolidation as compared to none in group-II. Significant statistical difference was observed in full lung expansion, partial lung expansion and clotted haemothorax between two groups (P<0.05).

Table-VI: Comparison of CT scan of chest findings (Post tube thoracostomoy) between groups.

CT Scan of Chest		Group-I (n=30)		Group-II (n=30)		*P* Value
		n	%	n	%	
Lung Expansion	Full lung expansion	29	96.7	23	76.7	0.026^{s}
	Partial lung expansion	1	3.3	7	23.3	
Clotted haemothorax	Present	1	3.3	7	23.3	0.026^{s}
	Absent	29	96.7	23	76.7	
Consolidation	Present	1	3.3	6	20.0	0.115^{ns}
	Absent	29	96.7	24	80.0	

^{s}=significant; ^{ns}=not significant
P value calculated from chi-square test.

Table-VII demonstrates chest tube duration of the study patients. Mean chest tube duration was calculated 7.13±2.1 days in group-I as compare to 11.83±5.26 days in group-II. The mean difference was statistically significant (P<0.05) between two groups.

Table-VII: Comparison of mean chest tube duration between groups.

Chest Tube Duration	Group-I (n=30)		Group-II (n=30)		*P* value
	n	%	n	%	
1-7 days	11	36.7	3	10.0	0.026^{s}
8-14 days	16	53.3	14	46.66	0.518^{ns}
15-21 days	2	6.70	6	20.0	0.145^{ns}
> 21 days	1	3.30	7	23.33	0.026^{s}
Chest tube duration (days)	Mean±SD 7.13±2.1	5-16	Mean±SD 11.83±5.26	6-28	0.001^{s}

^{s}=significant
P value calculated from unpaired t-test.

Table-VIII shows thoracotomy rate of the study subjects. 3.3% patients required thoracotomy as compared to 23.3% in group-II. This difference was statistically significant between two groups (P<0.05).

Table-VIII: Comparison of conversion to thoracotomy between groups.

CT Scan of Chest		Group-I (n=30)		Group-II (n=30)		*P* Value
		n	%	n	%	
Thoracotomy	Conversion to thoracotomy	1	3.3	7	23.3	0.026^{s}
	No conversion to thoracotomy	29	96.7	23	76.7	

^{s}=significant; ^{ns}=not significant
P value calculated from chi square test.

Table-IX shows duration of hospital stay of study subjects. Mean hospital stay was calculated 8.97±2.28 days in group-I as opposed to 13.47±5.53 days in group-II. The mean difference was statistically significant (P<0.05) between two groups.

Table-IX: Comparison of mean duration of hospital stays between groups.

Duration of Hospital Stay	Group-I (n=30)		Group-II (n=30)		*P* value
	N	%	n	%	
1-7 days	7	23.3	1	3.3	0.026[s]
8-14 days	15	50.0	13	43.3	0.245[ns]
15-21 days	7	23.3	9	30.0	0.245[ns]
> 22 days	1	3.3	7	23.3	0.026[s]
Hospital Stay Duration (day)	Mean±SD 8.97±2.28	6-18	Mean±SD 13.47±5.53	8-32	0.001[s]

[s]=significant

P value calculated from unpaired t-test.

Discussion

In this randomized controlled clinical trial, the mean age was found 36.73±12.88 years with a range from 10–65 years in group-I as compared to 40.97±14.45 years with a range from 18–70 years in group-II. The mean age of the present study was comparable with Muslim et al10 and Al-Azzawi[11]. More than three fourth patients of this study were male i.e. 76.7% and 83.3% patients in group-I and group-II respectively. Male to female ratio was 3.5:1. Male preponderance of the present study was comparable with Muslim et al[10] and Bilal et al[12]. Blunt chest trauma was observed 76.7% patients in group-I and 56.7% in group-II. On the other hand, penetrating chest trauma was found 23.3% patients in group-I and 43.3% group-II. In recent studies[13,14,15] researchers found that incidence of penetrating trauma significantly less than blunt trauma. These findings were comparable with the present study.

In this study, post tube thoracostomy patients were assessed by X-ray chest and CT scan of chest. X-ray chest was done immediately after tube thoracostomy, then every alternate day to assess lung expansion, status of haemothorax and haemopneumothorax. On the other hand CT scan of chest was done when partial lung expansion detected in X- ray chest and clinically inadequate drainage or altered blood in drainage bag. Radiologically, full lung expansion achieved 96.7% patients in group-I (P<0.05) as opposed to 76.7% patients in group-II and partial lung expansion associated with clotted haemothorax detected 3.3% patients in group-I as compared to 23.3% patients in group-II(P<0.05). These findings consistent with the study of Muslim et al[10], Al-Azzawi[11] and Bilal et al[12].

The study found mean chest tube duration 7.13±2.1 days with a range from 5–6 days in group-I as compared to 11.83±5.26 days with a range from 6–28 days in group-II. Muslim et al[10] observed mean chest tube duration 8.2±3.14 days with a range from 3–19 days in group-I as opposed to 12.6±4.20 days with a range from 7–24 days in group-II(P<0.05). In another study, Marshall et al[16] observed the mean time to removal of chest tubes 3.33±0.35 days in group-I and 5.47±0.98 days in group-II. These findings were consistent with our study. On the contrary, Adel[17] found that the mean duration of chest tube was lower in the water seal group (2.7 days) than in the suction group (3.8 days; p = 0.004). This finding was not commensurate with the present study.

This study observed that 23.3% patients of group-II underwent thoracotomy as compared to 3.3% patients of group-I. Among these patients, 6.7% underwent Video-Assisted Thoracoscopic Surgery (VATS) evacuation of clot & remaining 19.9% underwent open thoracotomy and evacuation of clot. Muslim et al[12] in their study, found that 6.0% patients of group-I underwent thoracotomy as opposed to 16.0% patients in group-II. These findings were comparable with present study. In our study, mean duration of hospital stay was 8.97±2.28 days with a range 6–18 days in group-I, where as it was 13.47±5.53 days with a range from 8–32 days in group-II. These findings were correlate with other studies[10,11,12].

Conclusion

The findings of present study and accumulating evidence from the other studies denotes that continuous low pressure suction expedites evacuation of blood and air, re-expansion of lung and reduces chances of development of clotted haemothorax in patients with traumatic haemothorax and/or haemopneumothorax, thereby it helps to reduce the number of thoracotomies performed for clotted haemothorax and empyema. The overall achievement is less morbidity, hospital stay and avoidance of cost of thoracic surgery.

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