Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/fnt5w820

CLINICAL EFFECT OF ADDING NEGATIVE PLEURAL SUCTION TO UNDERWATER SEAL CHEST DRAINS IN TRAUMATIC CHEST PATIENTS

Ahmed Nabil Malek[1*], Mohammed Farouk Abdel Hafez[1], Ahmed Ibrahim Ismail[1]

[1] [*]Department of Cardiothoracic Surgery, Faculty of Medicine, Assiut University Hospitals, Assiut, Egypt.

***Corresponding Author:** Ahmed Nabil Malek
[*]Department of Cardiothoracic Surgery, Faculty of Medicine, Assiut University Hospitals, Assiut, Egypt.

Abstract
Background: The target of this research work is to evaluate the effect of intercostal tubes with negative pleural suction against underwater seal in patients with various forms of chest trauma who received chest tube to manage the chest trauma complications including clotted hemothorax and persistent air leak.
Methods: Two groups were randomly assigned to patients who had tube thoracostomy due to traumatic pneumothorax, hemothorax, or hemopneumothorax: A negative suction was attached to the chest tube in group A, while no suction was attached in group B.
Results: Sixty patients were listed in the study, **30** in the group without negative suction and **30** in the other group with negative suction. The variances, which enrolled in this study between both groups, were in hospital stay **(p=0.391)**, air leak time **(p=0.49)** and other complications **(p=0.61)**. However, group A patients with negative suction had a higher chance to have more air leak time than group B patients.
Conclusion: Negative pleural suction decreased the incidence of surgical emphysema, but it did not show any advantages over the chest drainage system without suction in patients with simple traumatic pneumothorax, hemothorax, or hemopneumothorax.
Keywords: Thoracostomy; Chest tube, Chest tube, Traumatic pneumothorax; Hemopneumothorax; Hemothorax

Background

The most common cause of death in the first forty years of life is trauma, which is primarily caused by car accidents. Even while less than 50% of thoracic trauma cases required a surgical revision, they could still have serious consequences. The existence of an open wound in the chest determines whether a thoracic trauma is blunt or penetrating. Blunt trauma is the most common form of chest trauma, with or without rib fractures, and it may be associated with lung lacerations, hemothorax, pneumothorax, or hemopneumothorax [1].
When the pleural space is damaged, chest tubes are used to restore negative intrathoracic pressure. Chest drain insertion is expected to be required in case of a pleural damage with pneumothorax, haemothorax, or pneumo-haemothorax. We found it is interesting to investigate the effects of underwater seal with negative suction in one group of trauma patients and the underwater seal alone

without negative suction inn another group. We believe that a higher suction force will result in better outcomes for the patient, fewer problems, and a quicker return to normal life [2].

Methodology

This study was applied in the Assiut University Hospitals emergency department. A retrospective study was conducted on patients who were admitted to Assiut University Hospitals between October 2020 and October 2021 and required a chest tube insertion due to chest trauma. These patients were distributed into two groups.

• Group A: Patients had negative pleural suction on underwater Seal Chest Drainage System connected to negative suction.

• Group B: Patients on underwater Seal Chest Drainage system only.

Patients of all ages who present with pneumothorax, hemothorax, or pneumohemothorax are included in this study without any limitations. We excluded from the study [3,4]:

- Patients with multiple injuries.
- Patients with a history or on current thoracic operations.
- Patients with chronic pulmonary diseases (e.g. chronic obstructive pulmonary disease "COPD").
- Patients with severe brain Injury with Glasgow Coma Scale (GCS) of less than 8.
- Patients on mechanical ventilation.

Written informed consent was obtained from each patient who had negative pleural suction; those who refused were not included in the trial.

The technique of chest tube insertion was done in a classic way. The chest should be in flat position to allow the maximum widening of the spaces between the ribs. The ipsilateral arm should be directed backward and bended behind head and out of the procedure field.

The procedure was carried out in the fourth or fifth intercostal space on the mid-axillary line by the team of cardiothoracic surgeons. After injection of local anesthesia (2% lidocaine), a 1.5-2 cm cut was made and it was dissected to allow access to the pleural space.

The chest tube apparatus for group A patients was attached to a wall continuous negative suction system with a 20 cm H2O during the trial; it was only stopped when the patient moved to the restroom or the apparatus was switched.

Opioid analgesia was scheduled for all patients, and reinforcing analgesia was given as needed. Patients received spirometer to complete the respiratory exercises every hour, and nurses were told to remind patients to use the device. Within 24 hours following the chest tube insertion, a follow-up chest x-ray was obtained to assess lung re-expansion and hemothorax evacuation. Depending on the requirements of the surgical team responsible for the patient, radiologic examinations, ultrasound studies, or tomographic studies were carried out [5].

Data was gathered about the patient's diagnosis, the type of trauma and personal history. Daily records were kept of the existence or nonexistence of an alveolopleural fistula, the type of fistula based on the qualitative scale (continuous, inspiratory, expiratory, forced expiratory, or without fistula), and the liquid drainage and its properties (blood, serous, chylous and other). There was documentation of chest drain complications and the additional procedures e.g. new tube thoracostomy, thoracoscopy, or even thoracotomy.

The chest tube was left in place for at least twenty-four hours. The patient was ready to remove the chest drain if:

- Serous/hemorrhagic discharge of less than 50 mL per 24 hours.
- Free of respiratory symptoms e.g. dyspnea.
- Resolving of the pneumothorax/hemothorax on follow up x-ray examination.

The duration of hospital stay was the primary study outcome. Alveolopleural fistula persistence, clotted hemothorax, empyema, recurrent pneumothorax, and the requirement for further procedures (new thoracostomy, or thoracotomy) were the secondary outcomes that were assessed [6].

Master sheath data collection was followed by entry into Excel sheath data (MSEXCEL 2016). The statistical program Sigma Stat (version 3.5, Systat Software Inc.) was used for all analyses. The data were shown as means ± SD (standard deviation), medians with ranges, or frequencies, as applicable.

Results

There were 60 patients in the study, 30 in the negative suction group and 30 in the non-suction group. The demographic data of each group varied from each other [7].

The average **age** of the patients in group A was 36.6, whereas in group B was 34.8. Male prevalence in Group A was 86.7%, whereas group B had an 80% male preponderance. The age range was 18–62 years. The study's lowest number of patients is above 60 years old (Tables 1). According to this study, **smoking** is one of the risk factors that most patients have; in group A, it was found to be around 56.7%, and in group B, it was found to be around 53.3% [8]. Despite the fact that individuals who smoke actively have a higher risk of complications and prolonged hospital stays (Tables 2).

We utilized additive force on group A patients who present with negative pleural suction on under water seal chest drain system to accelerate recovery and shorten **hospital stays**. We discover at the end of the research work that group A's hospital stay lasted longer— **3.75 days**—than group B's, which lasted only **2.9 days**. Therefore, using negative pleural suction did not improve outcomes or shorten hospital stays (Table 3).

Pneumothorax or hemopneumothorax is one of the most common presentations of chest trauma patients, and the degree and duration of air leakage can be observed following the insertion of a chest tube. There are more patients with **air leaks** in group B (about 16 people), compared to group A (around 13 people). The length of the air leak was longer in group A (approximately 2.2 days) when we employed negative suction, compared to group B (about 1.4 days) without suction The p-value is highly significant (0.0001), indicating a strong difference between the two groups. (Table 3) [9].

The complications following the placement of a chest tube were registered in this study e.g. surgical emphysema, which can occur in some patients following chest trauma that results in pneumothorax or hemopneumothorax. Negative pleural suction, as used in group A, has the benefit of lowering the risk of **surgical emphysema** in group A (23%) in comparison with group B (30%) with insignificant P value (0.59) (Table 3) [10]. There are no significant differences in the other **complications** incidence (e.g. recurrent pneumothorax, clotted hemothorax, empyema, new thoracostomy or thoracotomy) between both groups. It just happened in 6 patients of group A and 8 patient of group B. The p-value is 0.54 which indicate no significant difference between the groups (Tables 3).

Insignificant differences between the groups were observed in the hospital stay **(p=0. 391)**, and complications **(p=0. 61)**. However, group A patients with negative suction had a higher chance to have longer time of air leak than in group B patients **(p=0. 0001)** (Tables 3) [7].

Discussion

Thoracic trauma is considered one of the challenges to be managed in a multi-traumatic patient because of the high rate of mortality and morbidity caused by its complications and its high cost of medical care. The majority of thoracic trauma patients are managed mostly with tube thoracostomy. According to each surgeon's preference, it is still uncertain if adding pleural negative suction to the collecting system is beneficial. Pleural negative suction is thought to accelerate hemothorax drainage and air leak closure [3] .

According to our research, there was no benefit to using negative pleural suction in comparison to a chest tube with underwater seal alone for the purpose of shorter hospital stays. We discover that group A hospital stay lasted longer time (3.75 days) than group B which lasted roughly 3 days [11].

Therefore, using negative pleural suction did not improve outcomes or shorten hospital stays. We discover that group A has an advantage that lowers the chance of surgical emphysema in about 75% of cases, whereas group B has a higher risk of this condition in around 30% of cases. The duration of the air leak was longer in group A after we applied negative suction, at around 2.2 days, than in group B, which did not employ suction, at around 1.4 days. This is a significant value (P value=0.0001) in our study [12].

Similar findings were observed by other authors, such as Ayed et al., who demonstrated that patients with negative suction had a higher frequency of persistent air leak (p=0.03), as well as longer hospital stays and average chest tube durations [4]. The use of suction resulted in an earlier resolution of air fistulas, as well as a shorter hospital stay and chest tube duration, in another randomized controlled experiment carried out by Marshall et al [5]. Negative suction was not found to reduce air leak closure time in our investigation. We think that the main reason for this phenomenon is that trauma patients have extremely low air leaks, and the chest tube's underwater seal alone allowed for a sufficient air absorption rate to evacuate the pneumothorax.

We choose to apply Brunelli et al.'s definition of a prolonged air leak, which is seven days. It is undeniable that the patients included in these trials are not trauma patients, mostly due to differences in age, pulmonary reserve, comorbidities, and the type of surgery they underwent [11]. No subject in our study had a continuous air leak. However, compared to patients who had pulmonary resections, which involve bronchial leaks, the vast majority of our cases presented with pulmonary parenchymal wounds due to the nature of the trauma. This difference probably explains why our patients are also more likely to have leaks that close more quickly.

According to a study by Davis et al., negative pleural suction decreased the duration of chest tube use (72.2 hours vs. 92.5 hours, p=0.013) and the interval between the air leak's resolution and tube withdrawal (25.2 hours vs. 35.6 hours, p=0.034) in 80 patients with tube thoracostomy due to chest trauma [13].

Conclusion

In patients with uncomplicated traumatic pneumothorax, hemothorax, or hemopneumothorax, the use of negative pleural suction did not show any advantages over the chest drainage system without suction; however, it did reduce the incidence of surgical emphysema. The study's findings are only applied on traumatic patients whom underwent tube thoracostomy. The majority of the participants in this study experienced penetrating trauma; more researches involving patients with blunt trauma is necessary to generate additional findings.

References

1. Prokakis C, Koletsis EN, Apostolakis E, et al. Routine suction of intercostal drains is not necessary after lobectomy: A prospective randomized trial. World J Surg. 2008; 32(11):2336-2342.
2. So SY, Yu DY. Catheter drainage of spontaneous pneumothorax: Suction or no suction, early or late removal? Thorax. 1982; 37(1):46-48.
3. Antanavicius G, Lamb J, Papasavas P, Caushaj P. Initial chest tube management after pulmonary resection. Am Surg. 2005; 71(5):416-419.
4. Ayed AK. Suction versus water seal after thoracoscopy for primary spontaneous pneumothorax: prospective randomized study. Ann Thorac Surg. 2003; 75(5):1593-1596.
5. Marshall MB, Deeb ME, Bleier JI, Kucharczuk JC, et al. Suction *vs.* water seal after pulmonary resection: A randomized prospective study. Chest. 2002;121(3):831-835.
6. Coughlin SM, Emmerton-Coughlin HM, Malthaner R. Management of chest tubes after pulmonary resection: A systematic review and meta-analysis. Can J Surg. 2012; 55(4):264.
7. Davis JW, Mackersie RC, Hoyt DB, Garcia J. Randomized study of algorithms for discontinuing tube thoracostomy drainage. J Am Coll Surg. 1994;179(5):553-537.
8. Morales Uribe CH, Villegas Lanau MI, Petro Sanchez RD. Best timing for thoracoscopic evacuation of retained post-traumatic hemothorax. Surg Endosc. 2008;22:91-95.
9. Cerfolio RJ, Bass C, Katholi CR. Prospective randomized trial compares suction versus water seal for air leaks. Ann Thorac Surg. 2001;71(5):1613-1617.
10. Brunelli A, Monteverde M, Borri A, et al. (2004) Comparison of water seal and suction after pulmonary lobectomy: A prospective, randomized trial. Ann Thorac Surg. 2004;77(6):1932-1937.

11. Brunelli A, Cassivi SD, Halgren L. Risk factors for prolonged air leak after pulmonary resection. Thorac Surg Clin. 2010; 20(3):359-364.
12. Alphonso N, Tan C, Utley M, et al. A prospective randomized controlled trial of suction versus non-suction to the under-water seal drains following lung resection. Eur J Cardiothorac Surg. 2005; 27(3):391-394.
13. Feenstra TM, Dickhoff C, Deunk J. Systematic review and meta-analysis of tube thoracostomy following traumatic chest injury; suction versus water seal. Eur J Trauma Emerg Surg. 2018; 44(6):819-827.

Table (1), Demographic data:

	Male no.	Female no.	Total	< 20 years	20- 60 years	> 60 years	Mean Age
Group A no.	26 (86.7%)	4 (13.3%)	30 (100%)	7 (23.3%)	20 (66.7%)	3 (10%)	36.6 ± 14.9
Group B no.	24 (80%)	6 (20%)	30 (100%)	8 (26.7%)	21 (70%)	1 (3.3%)	34.8 ± 14.1
P value							**0.622**

Table (2), Smoking rate:

	Smokers	Non-Smokers
Group A	17 (56.7%)	13 (43.3%)
Group B	16 (53.3%)	14 (46.7%)

Table (3), Post tube thoracostomy variables:

	Hospital stay (mean in days)	Air leak duration (mean in days)	Incidence of surgical emphysema (Patients no.)	Incidence of complications (Patients no.)
Group A	3.75± 0.72	2.2± 0.39	7 (23%)	6 (20%)
Group B	2.9± 0.65	1.4± 0.49	9 (30%)	8 (26.7%)
P value	0.391	**0.0001**	0.61	0.54