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Have Water Seal Drainage Systems Come to an End?

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Abstract

Background: We hypothesized that underwater seal drains are not mandatory after thoracic procedure when the visceral pleura remains intact. A small size drain with low auto-suction system (e.g., Hemovac) may be sufficient if no evidence of air leak.

Methods: This is an observational study on using low auto-suction drain as a solo pleural drain after thoracic procedures in which visceral pleura remained intact at the end of surgery. After completion of the procedure on the selected Cohort of patients, 10F Hemovac drain was inserted and fixed using 4/0 silk suture. Small collection bag, 250cc, was connected. To ensure tight wound closure around the small caliber drain, a tunneled insertion techniques using valve mechanism for at least one intercostal space was used. Finally, by the end of the procedure, Seal/Suction test should be utilized to test for the presence of air leak either from around the drain site or disintegrated visceral pleural surface. The primary outcomes were to detect the feasibility of low-suction drain after selected thoracic procedures. The secondary outcomes were to monitor the incidence of postoperative complications related to drainage system in the short term.

Results: the low-suction drain was used in 125 patients ranging between 4-86 years old. The drain was removed by the end of postoperative day 1 in 76%. Only 8 patients (6.4%) required drainage longer than 48 hours. Small apical air space (< 2cm) was detected on the immediate postoperative chest X-ray in only 8 patients (6.4%). Minimal pleural fluid was seen on the follow-up x-ray at one week in the outpatient clinic in 16 patients (%12.8). None of the patients required insertion of a chest drain or thoracocentesis. No complication related to using the Hemovac drain was reported.

Conclusion: Our observations suggest that low vacuum drainage systems are a feasible alternative to water-seal drainage systems in the remarkable number of thoracic procedures. This safe and practical drainage system could pave the way towards drainless surgery which is a culminating level for thoracic surgeons.

KEYWORDS
Low auto-suction drain, Seal-suction test, Underwater seal

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Introduction

After thoracic procedures, it is believed for long that drains connected to water seal drainage are mandatory not only for the evacuation of blood but also for removal of air originating from damaged visceral pleura to keep the pleural pressure negative [1]. Improved surgical techniques, routine use of staplers and extensive use of modern energy devices during thoracic operations result in better control of dissected area with minimal oozing from lymphatic and blood vessels and prevention of postoperative air leak from lung parenchyma [2]. Therefore, a trend to use vacuum-based mechanism pleural drains is growing within the thoracic surgery community while the use of conventional water seal drains is falling in favor.

In this study, we hypothesized that under water seal drains are not mandatory after thoracic procedure when the visceral pleura remains intact. A small size drain with low auto-suction system (e.g., Hemovac) may be sufficient if no evidence of air leak.

Patients and Methods

Ethical statement: This statement confirming the approval of the study by the ethical committee of Tekirdag Namik Kemal University on 29th November 2022, ID number 2022.216.11.17. All patients were consented, preoperatively, for the use of small low suction drain instead of the conventional underwater seal. Given the retrospective nature of study, the ethical approval was dated after patients were operated upon.

This is an observational study on using low auto-suction drain as a solo pleural drain after thoracic procedures in which visceral pleura remained intact at the end of surgery. This retrospective cohort study was performed at two different university hospitals between 2020-2022. Patients who had chest wall resection (>2 ribs), removal of large mediastinal masses, emergency major hemorrhage, dense pleural adhesions, and redo procedures were excluded. After completion of the procedure on the selected cohort of patients (Table 1), 10F Hemovac drain was inserted and fixed using 4/0 silk suture. Small collection bag, 250cc, was connected. To ensure tight wound closure around the small caliber drain, a tunneled insertion technique using valve mechanism for at least one intercostal space was used. This tightens the wound closure at the drain exit of the chest wall. This track can be done submuscular or subcutaneously. Finally, by the end of the procedure, seal-suction test should be utilized to test for the presence of air leak either from around the drain site or disintegrated visceral pleural surface. This test is simply exploited if the Hemovac drain fails to maintain suction (negative test) i.e., inflate after collapse. In such cases exclusion of unsealed system is mandatory by ensuring tight entry wound, sealed connectors, and uncracked tubes. All patients were consented, and the use of small auto suction drain was selected at the conclusion of the procedure after complete exclusion of any air leak as manifested by positive seal-suction test (i.e. hemovac drain maintains suction).

Postoperatively, patients were transferred to a recovery unit for few hours and subsequently to the thoracic surgical ward. On arrival, a chest X-ray was taken and not repeated afterwards unless necessary. The suction-seal and amount of drainage was hourly documented during the first 4 hours after the operation. Thereafter and up until drain removal, the chest drain was checked at least once in every shift, three shifts per 24 hours. This continuous evaluation by the surgical team aimed to early detection of suction failure and helped with early decision to swap to one way valve such as underwater seal drain if suction cannot be maintained.

On the surgical ward all patients followed a routine postoperative course, including pain, wound, blood, antibiotic, and comorbidities management. In addition to physiotherapy and nutritional support. Drains were removed by the nursing staff when the chest x-ray was deemed satisfactory by one of the surgical team members.

Patients were seen at the outpatient clinic a week after the procedure. Repeat chest x-ray was not required if breath sounds were normal on auscultation unless partial pneumothorax or

Table 1: Demography and the thoracic procedures performed where the visceral pleural remained intact

Demography		
Age	4-86 years	
Men	65	52 %
Women	60	48 %
Procedures		
Pleural biopsy	50	40 %
Talc Pleurodezis	19	15.2 %
Mediastinal procedure	16	12.8 %
Removal/biopsy of intrathoracic LNs	10	0.8 %
Exploration after thoracic trauma	6	4.8 %
Hematoma drainage	4	3.2 %
pleurectomy for pneumothorax	4	3.2 %
Diaphragmatic hernia/evantration	3	2.4 %
Pericardial biopsy/window	2	1.6 %
Rib biopsy	2	1.6 %
Chest wall resection	1	0.8 %
Thoracic outlet syndrome repair	1	0.8 %
Ligation of thoracic duct	1	0.8 %
Excision of parasternal lymph nodes	1	0.8 %
Excison Oesophagial leiomyoma	1	0.8 %
Nuss procedure	1	0.8 %
Intrathoracic goitre	1	0.8 %
Trachea-oesophagial fistula repair	1	0.8 %
Lung hernia via previous incision	1	0.8 %
Total	125	100 %

pleural effusion was detected on immediate postoperative chest X-ray. If any radiological finding but clinically insignificant abnormalities were detected, a second review in two weeks-time to follow the patient progression was planned.

The primary outcomes were to detect the feasibility of low-suction drain after selected thoracic procedures. The secondary outcomes were to monitor the incidence of postoperative pneumothorax and pleural effusion related to the drainage system in the short term.

Results

During the study period Hemovac drain was used in 125 patients ranging in age 4-86 years. The demographic data and the procedures undertaken was reported at Table 1. The visceral pleura over the pulmonary surface was not manipulated in all these procedures to avoid air leak. Only 3 patients (2.4%) had their surgery conducted through open thoracotomy. The remaining 122 (97.6 %) received VATS procedure.

The drain was removed between 6 to 56 hours after the procedure. During the postoperative course in only 6 patients (%4.8) the reservoir bag was emptied more than once. The drain was removed by the end of postoperative day 1 in 76% of cases most of which underwent pleural biopsy (52,6%). Prolonged drainage up to 48h was required in those cases who had talc pleurodesis (17.6%) to ensure pleural symphysis by the low suction mechanism. In only 8 patients (6,4%) required drainage longer than 48 hours (Table 2).

Radiologically detected small apical pneumothorax (< 2cm) was detected on the immediate postoperative chest X-ray in only 8 patients (%6.4) as shown in Table 2. Due to its clinical insignificance, conservative treatment was

decided. All these pneumothoraces were spontaneously absorbed on repeat x ray after one week without the need for any intervention. Minimal pleural fluid was seen on the follow up x-ray at one week in outpatient clinic in 16 patients (%12.8) of which only 9 patients needed to be followed up with a second out-patient visit undertaken 3 weeks from surgery. None of the patients required insertion of a chest drain or thoracocentesis. No complication related to the using Hemovac drain was reported.

Table 2: Average drainage time unit per day, frequency of reservoir drainage, and secondary outcomes of either Pneumothorax or effusion during the follow up period

	No. of patients	
Drainage time		
<24	95	76 %
24-48	22	17.6 %
>48	8	6.4 %
Emptied reservoir bag (> one)	6	4.8 %
Complications		
Pneumothorax (insignificant)		
Immediate (recovery)	8	6.4 %
1 week	0	
Pleural effusion (minimal)		
1 week	16	12.8 %
3 weeks	9	7.2 %
5 weeks	2	1.6 %

Discussion

The principles of chest drainage have not changed significantly since 1875 when Bülau introduced the idea of underwater drainage tube which became a trademark of thoracic surgery [3]. These principles include, firstly, prompt remove of fluid and air to restore negative pressure in the pleural space to allow lung re-expansion; and secondly, create one way valve mechanism to prevent drained air or fluid from returning to the pleural space. The same mechanism can also be elicited with flutter valve, or the Heimlich valves. The underwater seal itself has evolved over the years to improve its efficacy, however, the one-way valve mechanism remained an essential part. The single chamber water seal which principally relied on passive drainage is evolved to become active drainage systems by applying suction on chest drains. Nevertheless, the disadvantages even with using the most recent three bottle system included but not limited to adherence to the wall suction, possibility of drainage return into the thoracic cavity, difficulty in patient's mobilization, requirements of hospital admission during treatment, and the relative complexity of the set up [4-6].

Recently, the vacuum seal mechanism has been introduced as a corner stone pillar for the digital electronic drainage systems (DDS). This implementation of vacuum-based mechanism for drainage has altered the attitude towards pleural drainage. These systems facilitate patients' ambulation without restriction and active drainage of the thoracic cavity resulting in early postoperative discharge [7]. Thus, an increasing trend on using active drainage systems has been observed among thoracic surgeons in the recent years. On the other hand, DDS are expensive to operate and yet to be widely available. The Committee of NICE Medical Technologies Guidance reported that the evidence presented for DDS is mainly for its use in patients undergoing pulmonary resection [8,9]. We believe that DDS is not required after the thoracic procedures of which air leak is not a main concern. Therefore, we introduced the innovative idea to utilize the similar active drainage mechanism by using a low-pressure vacuum drain rather than using passive water-seal drainage system.

The results of this series suggest that low auto suction drain safely substitutes the one-way valve when the visceral pleural remained intact and combines the simplicity along the continuous suction when required. Low suction hastens the removal of air and fluid, thereby eliminating residual space and expediting lung re-expansion when there is no evidence of air leak. In addition, these portable small caliber drains encourage early mobilization and associated with lesser pain, shorter hospital stays and lower cost. Of note, because of the observational design of the current study, we did not report the other beneficial effects of this technique on pain score, comfort score, and length of hospital stay.

Limitations

Because of the observational design of the current study, we did not report the other beneficial effects of this technique on pain score, comfort score, and length of hospital stay.

Conclusion

Our observations suggest that low vacuum drainage systems are a feasible alternative to water-seal drainage systems in the remarkable number of thoracic procedures. This safe and practical drainage system could pave the way towards drainless surgery which is a culminating level for thoracic surgeons.

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