Thorax 1992;47:461–462

Randomised clinical trial of chest drainage systems

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Abstract

Background **Problems in the management of thoracic trauma have stimulated the search for an alternative to underwater seals for drainage of the pleural cavity. A chest drainage bag incorporating a one way flutter valve has been compared with underwater seal drains in a randomised clinical trial.**

Methods **During June–December 1989 119 patients undergoing elective thoracotomy were randomised to receive postoperative chest drainage by drainage bags (56 patients, 87 drains) or by underwater seal drains (63 patients, 98 drains). Daily drainage volumes, the requirement for pleural suction, mobility, and complications were recorded prospectively.**

Results **There was no significant difference between the two groups in the mean volume drained, the requirements for pleural suction, or the occurrence of complications. Patients with drainage bags were fully mobile 23 hours (95% confidence interval 0–47 hours) earlier than the others.**

Conclusions **When used after elective thoracotomy drainage bags are safe and effective and permit earlier mobility than underwater seal drains.**

Underwater seal drainage, in its present form, was first described by Kenyon in 1916[1] and since then has been the standard form of chest drainage. It has several disadvantages that make it unsuitable for use outside hospital in an emergency. The underwater seal bottles are bulky and must be kept upright and the drains are usually clamped during transport—a potential danger. Various attempts have been made to find a suitable alternative, the most successful using a Heimlich valve connected to a plastic bag.[2] This was the method used by the British forces for emergency chest drainage during the Falklands war. It was fairly successful, though the valves tended to become blocked and sometimes disconnected from the drain.[3] In 1981 Thompson showed that bags with an integral non-return valve could be used for chest drainage[4] and Matthews has used this system successfully for ambulatory patients outside hospital.[5] A drainage bag incorporating a one way flutter valve and a vented outlet (Portex UK) has recently been launched, and we have compared this drainage bag with underwater seal drains in a randomised trial.[6]

Methods

Patients undergoing elective thoracotomy for various conditions during June–December 1989 were randomised to receive postoperative chest drainage by drainage bags or by underwater seal drains (Portex Emergency Drainage Bags and Portex Pleural Drainage Bottles). Randomisation was carried out by selecting an unmarked envelope before the chest was closed. Patients were excluded from the study if it was decided during the operation that they would require pleural suction postoperatively.

All operations were carried out under general anaesthesia with a double lumen endotracheal tube. The approach was via a standard lateral thoracotomy except in the following cases. Anterior thoracotomy was performed via a 10 cm incision over the anterior aspect of the second intercostal space. Total thoracic oesophagectomy, oesophagogastrectomy, and total gastrectomy were performed via a left thoracoabdominal incision. Open lung biopsy was via a short lateral incision and thymectomy was via a median sternotomy.

Data were collected from each patient prospectively and recorded on a prepared proforma. They included the daily volume of the fluid drained, the time of application of any pleural suction, and the time of removal of drains. Suction was administered with a Robert's pump at 3–5 mm Hg. If pleural suction was required in a patient with a drainage bag this was replaced with an underwater seal drain. The drainage bag was reattached after suction was discontinued. The results were analysed according to the initial treatment (on an intention to treat basis).

The length of time from the end of the operation until the patient sat out of bed in a chair was recorded as the "time to sitting." The time when the patient was first able to walk to the toilet unaided was taken as the time to full mobility. All complications occurring during the patient's hospital stay and all deaths within 30 postoperative days were recorded. A chest infection was diagnosed when there was a raised temperature associated with purulent sputum. The criterion for diagnosis of a wound infection was purulent discharge with a positive bacteriological culture.

For statistical analysis the χ^2 and Student's t tests were used as appropriate. Statistical significance was accepted when p was below 0·05. Analysis was carried out on a MicroVax II computer with the SPSS-X statistical package.

Results

One hundred and nineteen patients entered the trial and an additional 29 were excluded. The ages of those in the trial ranged from 18 to 76 (mean 53·2) years and the male to female ratio

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Accepted 16 January 1992

Table 1 Operations in the two groups of patients

Operation	No of patients with drainage bag	No of patients with underwater seal drain	Total
Lobectomy	12	8	20
Open lung biopsy	3	10	13
Pleurodesis or stapling of bullae	7	6	13
Wedge excision	11	2	13
Anterior thoracotomy	7	5	12
Lateral thoracotomy	4	5	9
Pneumonectomy	3	4	7
Total thoracic oesophagectomy	2	5	7
Oesophagogastrectomy	1	5	6
Belsey mark IV repair	1	3	4
Other	5	10	15

was 3·25:1. Lung cancer was the most common diagnosis (n = 62) followed by recurrent pneumothorax (14) and oesophageal cancer (13). Drainage bags were used in 56 patients with 87 drains and underwater seal drains in 63 patients with 98 drains. There was no significant difference between the two groups of patients with respect to age, sex, diagnosis, or operation. The distribution of operations between the two groups is shown in table 1.

The mean total volume of fluid drained by drainage bags was 611 (SD 567, 95% confidence interval 457–765) ml and by underwater seal drains 616 (499, 95% CI 488–744) ml.

Postoperative pleural suction was required in seven patients with a drainage bag and in 13 with an underwater seal drain (χ^2 = 1·40, p = 0·239). It was required in six of 13 patients who had a pleurodesis and stapling of bullae, compared with 14 of 106 patients who had other operations (χ^2 = 8·99, p = 0·003). No other operation had a significantly increased requirement for suction.

The mean duration of chest intubation was 77 (95% CI 65–88) hours in patients with a drainage bag and 76 (95% CI 66–86) hours in those with an underwater seal drain. The mean times to sitting, full mobility, and discharge are shown in table 2; patients with a drainage bag took a shorter time to achieve full mobility than those with an underwater seal. The incidence of postoperative complications was similar in the two groups—seven (12%) in patients with a drainage bag and 11 (17%) in patients with an underwater seal drain (table 3). There were two perioperative deaths, both from respiratory failure and both in the group with underwater seals.

Discussion

In this study the drainage bags were as effective in draining the chest of blood as an underwater seal drain, and as effective at draining air unless pleural suction was required. This, however, is usually not necessary in postoperative cases, and only 20 patients required it in this study. Suction was required less often for patients with a drainage bag, though the difference was not significant, and significantly more often with patients who had pleurodesis and stapling of bullae.

Table 2 Mean (SD) time taken by patients in the two groups to sit in a chair, become mobile, and be discharged

	Drainage bag (n = 56)	Underwater seal drain (n = 63)	p*
Time (hours) to sitting in chair	47 (14)	54 (35)	0·104
Time (hours) to full mobility	82 (39)	105 (80)	0·044
Time (days) to discharge	10 (5)	11 (6)	0·263

*Student's *t* test.

Table 3 Postoperative complications in the two groups of patients

Complication	No of patients with drainage bag	No of patients with underwater seal drain
Chest infection	3	4
Accidental drain removal	2	2
Persistent air leak	2	1
Anastomotic leak	1	0
Mediastinal sepsis	0	1
Acute laryngeal oedema	0	1
Femoral artery embolus	1	0
Wound infection	0	0

Patients with a drainage bag were fully mobile on average 23 hours earlier than those with an underwater seal drain. They were also able to sit in a chair seven hours earlier and were discharged one day earlier, though these differences did not reach statistical significance. In the early part of the study there was less difference between the two groups in the time taken to become mobile, possibly because the nursing staff were initially reluctant to encourage patients to walk with their drains in place. Towards the end of the trial fewer restrictions were placed on the patients.

Heimlich valves often become blocked if used to drain blood from the chest[2 3]; with the Portex valve there were no cases of blockage in our study—despite the large volumes of blood drained in some cases. In addition, only two drains in each group fell out accidentally.

The advantages of drainage bags over underwater seal drains include earlier mobility, smaller storage volume, and lower cost. They also avoid the need for the drain to be clamped during transfer and can safety be used in mobile patients outside hospital. Their use in some postoperative cases is limited because they cannot be attached to suction. In our current management of postoperative patients we have found them to be complementary to underwater seal drains. Their advantages make them ideal for use in thoracic trauma. Our study has shown that drainage bags are safe and effective when used after elective thoracotomy.

We thank Portex (UK) for supplying the drainage bags used in this study and the nursing staff of wards 13 and 14, the main block theatres, and the general recovery ward at the Royal Victoria Hospital for their cooperation during the trial. We also thank Mr A T Chivers for help with statistical analysis and Cathy Gilmartin for the illustrations.

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