Routine underwater seal drains are not required after transthoracic oesophagectomy: a pilot study

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Abstract

Objective: Underwater seal drainage of the pleural cavity has been standard practice after transthoracic oesophagectomy. However these chest tubes cause pain and hamper mobility, thereby causing significant morbidity and delaying recovery. We postulated that if complete lung expansion and optimum pulmonary function could be achieved and maintained following a transthoracic oesophagectomy using simple gravity aided transabdominal tube drainage of the pleural cavity, then these may be a simpler alternative to the conventional underwater seal chest drains. Methods: A total of 50 patients had transthoracic oesophagectomy for oesophageal cancer. Of the cohort, 44 patients were fitted with the transabdominal drain described and hence had ‘modified pleural drainage’ following the oesophagectomy. All patients had a posterior mediastinal drain placed in either the right or the left pleural cavity during the oesophagectomy. The tube drain was inserted into the pleural cavity from the abdomen and placed into the desired position across the diaphragmatic hiatus. The drain was managed in the conventional manner and patients were monitored postoperatively for any developing pleural collections through serial chest X-rays. Respiratory function was closely monitored. Results: The drains were removed without any significant respiratory complications by the 8th postoperative day in 86% of the patients. Only three patients (7%) developed clinically significant recurrent pleural effusions, causing respiratory compromise meriting further drainage. This was easily and safely managed using fine bore pigtail drains inserted under ultrasound guidance. Conclusion: Transabdominal gravity aided tube drainage of the mediastinum and the pleural cavity is an effective and safe means of draining the chest, following uncomplicated transthoracic oesophagectomy.

1. Introduction

Pleural drainage after thoracic surgery is necessary to evacuate excessive amounts of air and fluid from the operated chest allowing for full lung re-expansion. This facilitates optimum ventilation, promotes recovery and minimises the risk of hypoxic complications due to suboptimal pulmonary function [1,2]. Thus pleural drainage has been an inbuilt component of a transthoracic oesophagectomy [2]. Conventional drainage involves one or two medium to wide bore tube drains (depending on surgeon preference and practice) connected to an underwater seal through an intercostal incision [2–4]. Negative intrathoracic pressures are restored and complete lung expansion is achieved. [3,4]. Lung expansion reactivates the surface forces that hold the parietal and visceral pleurae together thereby maintaining lung expansion [3,4]. Paradoxically however, rigid intercostal tubes reduce respiratory effort by causing significant pain, hampering both mobilisation and recovery [2,5,6]. Furthermore these tubes can potentially be inadvertently mismanaged by inexperienced staff leading to harm. Apprehending these potential disadvantages, we created a new and a different method of draining the chest following transthoracic oesophagectomy with a simple gravity aided transabdominal tube drain placed in the chest across the diaphragmatic hiatus. We present our initial experience with these herewith.

2. Materials and methods

Over a period of 18 months 50 patients underwent oesophagectomy for adenocarcinoma at a tertiary referral centre and regional oesophagogastric cancer unit. Data was analysed retrospectively, for this observational study and 44 patients who had the ‘modified pleural drains’ (described later) during oesophagectomy, qualified for the same. There were 32 males and 12 females with a mean patient age of 66
years (39–85). Choice of procedure was dictated by the location of the primary tumour. Those with mid-lower adenocarcinomas, including Siewert type 1 cardio-oesophageal (CO) junction tumours, underwent the Ivor-Lewis procedure (laparotomy and right thoracotomy; 34 patients). Those patients with Siewert type 2 and 3 CO junction tumours underwent distal oesophagectomy and proximal gastrectomy through single left thoracoabdominal incision across 8th rib bed (10 patients). The remaining six patients who also underwent transthoracic oesophagectomy during this period were excluded from the study. They had the conventional 'underwater seal' chest tubes inserted. Decisions for the same were based on operative events and intraoperative findings. Decisions to do so in these select patients were based on the surgical judgement of the consultant surgeons. Two patients had significant oozing from the mediastinal ‘bed’ associated with difficult surgical dissection, necessitating a chest tube to drain an anticipated significant postoperative effusion. Two patients had a thoracic duct leak and drains were used presumptively for possible chylothorax. In both these patients the duct was individually underrun in continuity in the lower mediastinum. Two patients had an air leak from the lung parenchyma, during separation of the lung from pleural adhesions. Hence they had underwater seal chest drains placed in anticipation of a possible air leak and resulting pneumothorax. Thus in these six patients, the ‘modified pleural drains’ placed at laparotomy were removed at completion of thoracotomy.

2.1. Surgical procedure and postoperative management

In patients undergoing Ivor-Lewis oesophagectomy at laparotomy once the conventional gastric mobilisation based on the right gastroepiploic arcade was completed, a size 30 F tube drain was placed in the lower chest, across the diaphragmatic hiatus, positioned in the lower posterior mediastinum, completing the abdominal stage of the procedure (Figs. 1 and 2). Oesophagectomy through a right thoracotomy was completed by guiding the stomach into the thorax and creating a tube using a TLC 75 linear stapler (Ethicon, Johnson & Johnson, Inc.). The mediastinal drain inserted during the laparotomy was located easily and accurately re-positioned posterior to the oesophagogastric anastomosis (Figs. 1 and 2). Isolated left lung ventilation enabled the right lung to be collapsed during the thoracic component of the operation. At completion of the procedure the anaesthetist re-inflates the lung under direct vision and normal double lung ventilation restored. An analogous procedure with isolated right lung ventilation was performed in patients resected through the left thoracoabdominal approach. The drain was positioned at an equivalent position in the left hemi-thorax through the reconstructed diaphragmatic hiatus (Fig. 3). The drain technically therefore is a chest drain placed transabdominally across the diaphragmatic hiatus (Figs. 1–3). The drain in all instances is connected to an ordinary drainage bag allowing drainage by gravity. All operations were inclusive of enbloc regional lymphadenectomy in the upper abdomen and mediastinum, with end to side single layered oesophagogastric anastomoses using 3-0 PDS (Polydioxanone, Johnson & Johnson, Inc.). All patients prior to closure of the thoracotomy had an

![Image](https://academic.oup.com/ejcts/article-abstract/35/4/694/368990)
intrapleural catheter inserted for continuous intrapleural bupivacaine infusion. All patients were extubated immediately or within 3 h of completion of the surgical procedure. Postoperative intravenous analgesia was supported by a combination of intrapleural bupivacaine (0.25% at 8 ml/h) and an epidural combination (0.1% bupivacaine at 8—20 ml/h and 2 μg/ml of fentanyl as continuous infusion) managed by a specialist pain team.

The epidural analgesia was discontinued beyond postoperative day 5 and replaced with morphine based patient controlled analgesia (PCA) until day 7—10 until the patient was comfortably taking orals, substituting the same with oral analgesics. Intensive chest physiotherapy was given to all patients. All patients had serial chest X-rays on postoperative days 1, 2, 5, 7 and 10. Further X-rays if clinically indicated were performed. Further films were taken before discharge and where clinical need dictated (Figs. 4 and 5). Drain output in terms of quantity and nature of the drainage was carefully followed up. A criterion for drain removal was the production of less than 100 ml of clear serous drainage over 24 h for 48 h. All patients were monitored in the intensive care/high dependency unit for at least the first 5 postoperative days. All patients were given total parenteral nutrition (TPN) for 10 days following surgery, until resumption of adequate oral feeds. Statistical analysis was carried out on this observational study and 95% confidence intervals (CI) for the clinically relevant findings calculated. The observational results were expressed as a percentage.

3. Results

The 30-day mortality was zero. Recovery was uneventful without any significant surgical complication in 41 patients (93%, 95% CI = 86—100%). Three patients (6.8%) had significant postoperative complications (95% CI = 0—15%). Two patients had anastomotic leaks (4.5%, 95% CI = 0—11%), while one patient (2.2%) had a thoracic duct leak resulting in a chylothorax (95% CI = 0—7%). The anastomotic leak in the first patient was major, however, it was well controlled by the drain, ceasing with conservative management after 59 days. The second patient had a high volume leak associated with little clinical change. This again stopped with conservative management within 21 days. The third patient, having a thoracic duct leak, had discharge delayed by 28 days and necessitated long-term drainage. Response to the chyle leak was conservative management with TPN, and a fat-free oral intake instituted when tolerated. Mean duration of stay in intensive care/high dependency unit was 4.9 days (3—51 days). Mean hospital stay was 13 days (10—78 days). Mean time to removal of the drains in these 44 patients was 7.4 days (6—62 days). Three patients (6.8%) developed a clinically significant ipsilateral pleural effusion within 4 days of drain removal (day 3 and day 4 respectively) (95% CI = 0—
15%). All effusions initially seen on a plain chest X-ray were promptly confirmed and drained under ultrasound guidance using a 12 F fine bore pigtail drain. Re-removal was quick, an output of zero reached within a mean time of 2.7 days. None of these patients had a recurrent effusion thereafter. Small pleural effusions causing only mild dyspnoea were noted in a further three patients (6.8%, 95% CI = 0—15%). These resolved spontaneously without requiring any intervention (95% CI = 0—15%). Pleural effusions were deemed for drainage if the patient had accompanying clinically relevant symptoms such as dyspnoea grade 2, an increased requirement for oxygen more than 4 litres/min and a fall in the oxygen saturation below 90% on pulse oximetry. Four (9.08%) patients developed a contra lateral left pleural effusion necessitating drainage (95% CI = 0—18%). There were no clinically significant pneumothoraces in any of these patients. Thus 38 patients (86.36%), had a smooth, uneventful and uncomplicated postoperative course following oesophagectomy [8—11]. Removal of these tubes is associated with a significant relief of pain promoting quicker mobilisation and recovery [5,6]. Reports exist that these tubes can cause chronic neuralgic symptoms due to intercostal nerve damage [2]. In our present series, optimum postoperative analgesia with judicious combination of epidural, intrapleural and intravenous analgesia and intensive postoperative monitoring of these patients in the HDU, ensured lung expansion thereby obviating the need for conventional underwater seal chest tubes. Law et al. found small bore vacuum drainage of the pleural cavity to be equally as effective and causing lesser discomfort, hampering mobilisation and delaying recovery [2,7,12]. Thus they contribute to the pulmonary morbidity following oesophagectomy [8—11].

### Table 1

<table>
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<th>Summary of data and results.</th>
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<td><strong>Total number of patients undergoing transthoracic oesophagectomy</strong></td>
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<td><strong>Number of patients in whom 'modified pleural drainage' described herein (included in the present pilot study)</strong></td>
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<td><strong>Ivor-Lewis procedure (laparotomy and right thoracotomy)</strong></td>
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<td><strong>Left thoracoabdominal approach (distal oesophagectomy + proximal Gastrectomy)</strong></td>
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<td><strong>Uncomplicated postoperative course without any surgical complications/recurrent effusions</strong></td>
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Conventionally underwater seal chest tubes have been an inbuilt and indispensable component of a transthoracic oesophagectomy, helping to restore and maintain negative intrathoracic pressures, facilitating complete lung expansion following purposeful lung collapse during oesophagectomy [2,7]. Additionally, drains provide a safety net; minimising the incidence of postoperative pneumothorax and help in the prompt detection of postoperative haemorrhage. We do believe that with good chest physiotherapy, early mobilisation and optimum analgesia, complete pulmonary re-expansion can be maintained in the postoperative period and conventional underwater seal chest tubes are not required to ensure this. Drainage of the pleural cavity and mediastinum, after uncomplicated transthoracic oesophagectomy can be effectively achieved by the ‘**transdiaphragmatic modified pleural drains’**, described herein. In fact we believe and as our present experience has shown these modified chest tubes are equivalent in function to the traditional underwater seal tubes. Pulmonary complications are a major cause of morbidity and mortality following oesophagectomy [8—11]. Although the thoracotomy incision causes significant pain and discomfort, hampering mobilisation and delaying recovery, the contribution of chest tubes in this regard should not be underestimated. The rigid chest tubes, exiting from between the ribs and stitched to the chest wall are a significant source of pain and discomfort, hampering mobilisation and delaying recovery [2,7,12].

4. **Discussion**

Safe and effective closed chest tube drainage without underwater seals has been described before in a variety of clinical situations including after oesophageal surgery [16—18]. These have included infective and transudative pleural effusions. In our present study, the modified tubes placed provided successful drainage of the pleural cavity in the majority of our patients. Although purely based on our personal experience and belief, the discomfort and morbidity from a drain exiting from the abdomen appears to be much less than an equivalent and similar drain exiting from the chest wall. Part of this belief also stems from the fact that tube drains used routinely in conventional abdominal surgery, are safe and are not associated with any significant morbidity including pain. The close and intensive postoperative monitoring of these patients in the...
high dependency environment also facilitated quick recognition and optimum management of any complications should they have happened. The three recurrent effusions in this present study were effectively treated with fine bore drains under ultrasound guidance. These and the contralateral pleural effusions are likely to have occurred irrespective of the nature of the drain used. Thus substituting the conventional underwater seal tubes with ‘transabdominal transdiaphragmatic modified pleural drains’ following oesophagectomy did not compromise patient care or impede pulmonary function delaying recovery. Unlike pulmonary surgery that may be associated with some degree of parenchymal air leak requiring underwater seal drainage, an uncomplicated transthoracic oesophagectomy does not increase any chances for a postoperative pneumothorax and hence does not merit conventional underwater seal drainage. Hence we postulate that if adequate lung expansion can be ensured and maintained with adequate analgesia and physiotherapy, conventional underwater seal chest tube drains are not required. Should the tubes be required for any reason in the postoperative period, they can be safely inserted. The average length of stay (4.9 days) in the ‘more protected environment’ of the high dependency unit, made us more confident of employing this different method. Our experience has shown that gravity aided simple transabdominal transdiaphragmatic tubes are equivalent in function to traditional underwater seal chest tubes. The practice can be routinely and reliably followed in all patients with an uncomplicated transthoracic oesophagectomy. Circumstances commanding conventional underwater seal drains are limited to air leaks from lung injury, excessive oozing and thoracic duct injury. Limitations of this pilot study lie in part with the retrospective nature of the case series. A small sample of 44 patients was reflected in the wide confidence intervals. Absence of controls makes the ascertainment of significance difficult. We believe that effective drainage of the pleural cavity and mediastinum after uncomplicated transthoracic oesophagectomy can be achieved with the transabdominal transdiaphragmatic modified pleural drains. A randomised controlled trial and studies involving larger number of patients are required to further test this hypothesis.

References