Editorial

Thoracic drain management using a digital system

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Comment on: Geraci TC, Sorensen A, James L, *et al*. Use of a novel digital drainage system after pulmonary resection. J Thorac Dis 2022;14:3145-53.

Keywords: Thoracic drain; digital drainage system; drain management

Submitted Nov 25, 2022. Accepted for publication Dec 23, 2022. Published online Jan 09, 2023.
doi: 10.21037/jtd-22-1692
View this article at: https://dx.doi.org/10.21037/jtd-22-1692

Introduction

In routine clinical practice, it is up to the surgeon to decide when to remove the postoperative drain in perioperative management. Thoracic drains can cause pain and infection and impede mobilization. In addition, the duration of drain insertion has a significant impact on the length of hospital stay. Appropriately timed removal of thoracic drains facilitates improvement of the patient's quality of life and early postoperative recovery of lung function by reducing postoperative pain (1-3). Therefore, surgeons should remove the chest tube as soon as possible when it is no longer required.

Guidelines by the European Society for Thoracic Surgery to facilitate recovery after pulmonary surgery indicate that digital drainage systems offer several advantages over analog systems (4). The advantages of the digital drainage system are as follows: (I) these devices are lightweight, compact, and do not require connection to the wall suction because of the integrated suction pump, which is advantageous for patient transfer. (II) Information on air leaks can be objectively quantified and stored over time, thereby eliminating variability in clinical judgement. Thus, decision-making regarding chest tube removal is easier (5). The avoidance of external aspiration and use of digital drainage systems were both shown to have low level of evidence but a strong level of recommendation. It should also be noted that the recommended criterion for chest tube removal in relation to pleural fluid volume is a maximum of 450 mL/24 h (level of evidence: medium; recommendation: strong). The Thoraguard Surgical Drainage System (Centese, Omaha, Nebraska) is a novel Food and Drug Administration-approved [510(k), K181667] system. This device has a drainage system that automatically unclogs without the need for clinician intervention. The drainage system is also a device that can digitally measure and display air leakage rates and 24 h trends after thoracic surgery. Geraci *et al.* retrospectively evaluated the safety and feasibility of the Thoraguard system in comparison with an analog drainage system in patients who underwent robotic pulmonary resection (6). While studies on postoperative drain management using digital systems already exist in literature, the authors have presented clinical data that will be valuable in the future expansion of the clinical use of this novel device.

Objective assessment of air leaks and surgical outcomes

Plourde *et al.* evaluated 215 patients, with 107 patients randomly allocated in the digital group (ATMOS, MedizinTechnik, Sulz, Germany) and 108 in the analog group (7). In their postoperative drainage setup, a negative pressure of –20 cmH_2O was initially set for both devices. On postoperative day 1, the chest tube was set to a water seal for the analog device and –5 cmH_2O for the digital device. The chest tube was removed after 12 h of airflow of less than 30 mL/min in the digital group. If air leakage was unknown, the chest tube was clamped, and lung expansion was assessed using chest radiography 2 h after clamping. The digital system objectively quantified air leaks and reduced the number of chest tube clamps to 47% in the analog group and 19% in the digital group (P<0.0001). However,

there was no significant difference in the outcomes for the length of hospital stay, chest tube duration, and chest tube reinsertion (P=1, 0.71, and 0.21, respectively). Digital systems reduce subjectivity and provide an accurate and objective assessment of air leaks. Randomized clinical trials comparing digital and analog devices reported shorter duration of chest tube placement and hospital stay following pulmonary resections (8-10). However, other randomized trials found no difference in chest tube indwelling time or length of hospital stay between analog and digital devices (11-13). In the Thoraguard system study, the chest tube was set to the 'suction' of –20 cmH_2O immediately after surgery in all patients. On postoperative day 1, the chest tube was set to 0 cmH_2O 'water seal' (disconnected from suction). In the Thoraguard group, a flow rate of 0 mL/min was considered as the cessation of air leakage, and the chest tube was removed. If the air leak flow rate remained below 20 mL/min for more than 6 h, the chest tube was removed at the surgeon's discretion. This device could detect a higher number of air leaks than an analog system [36/50 (72%) *vs.* 45/200 (23%), P<0.001]. The Thoraguard system was associated with a decreased chest tube duration of 1 day [interquartile range (IQR) 0–2] *vs.* 2 days (IQR 2–3) (P=0.042) and a hospital length of stay of 2 days (IQR 2–3) *vs.* 3 days (IQR 2–4) (P=0.027). Objective quantification of air leakage showed that digital devices enabled better postoperative management than analog methods. Since the median operative time was significantly shorter in the Thoraguard group than in the analog group (122 *vs.* 149 min, P=0.003), their study was retrospective and did not address the greatest bias in proficiency in the surgical technique. Furthermore, sufficient evidence has not been presented to quantitatively assess patient satisfaction and activity limitations during mobilization. However, the Thoraguard system has a reputation for its high air leak detection capacity, ease of patient transfer, and good display of clinically relevant information in user evaluations of its use, which are its unquestionable advantages.

Effects of postoperative suction pressure

In the management of chest drains after pulmonary resections, the clinician's preference is reflected in whether suction is required and how much suction pressure is applied. In major air leaks, no suctioning is associated with an increased risk of complications, such as poor lung dilation, pneumonia, and arrhythmias (14). In analog drainage management, several studies compared external suctioning with a water seal but failed to show superiority in postoperative outcomes in terms of duration of air leak, incidence of prolonged air leak, duration of chest drainage, and length of hospital stay (15,16).

Regarding the use of digital devices, Lijkendijk *et al.* evaluated chest drainage algorithms with electronic chest drainage systems and a randomized controlled trial comparing low-suction (–5 cmH_2O) versus high-suction (–20 cmH_2O) using a digital drainage system (Thopaz Digital Chest Drainage System, Medela AG, Baar, Switzerland) (17). The drain removal algorithm was based on a digital display with no visible spikes and a reduction in airflow to 20 mL/min for 6 h continuously or 50 mL/min for 12 h continuously. This air leakage criterion was reasonable because the previous air leakage criterion for digital system was 6–12 h between airflows of <20 L/min and 50 L/min (10,18,19). There were no clinical differences in the duration of chest drain insertion or length of hospital stay. However, complications requiring chest drain reinsertion were significantly more frequent in the low suction group (P=0.03). They suggested that a drainage system should not be used under low suction levels after lobectomy. False-negative assessments of air leaks due to low suction pressure undermine the reliability of drainage management. In the Thoraguard system study, the chest tube was set to –20 cmH_2O after surgery and to 0 cmH_2O on postoperative day 1. Before removing the drains, the air leak flow was 1.5 mL/min (IQR, 0–4). The largest measured air leak flow prior to removal was 18 mL/min. None of the patients in the Thoraguard group developed post-pull pneumothorax requiring chest tube reinsertion. From their early experience, they predicted this threshold to be an air leak of ≤15 mL/min. Further research using digital data may help determine an acceptable rate of air leakage following pulmonary resection, which is safe for chest tube removal. It remains unclear whether low- or high-negative-pressure drainage management with digital systems is better. Further clinical data are needed to determine appropriate suction pressure and criteria for chest drain removal in digital system management.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Journal of Thoracic Disease*. The article did not undergo external peer review.

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1692/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Cite this article as: Nakada T, Ohtsuka T. Thoracic drain management using a digital system. J Thorac Dis 2023;15(2):219-222. doi: 10.21037/jtd-22-1692