Thoracic Drainage

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ABSTRACT

The Digital Chest Drainage (DCD) is a portable digital system that has been evaluated since 2008. Clinical evidence showed that the use of DCD leads to shorter drainage times, a shorter hospital stay, lower rates of chest drain re-insertion and higher patient satisfaction compared to conventional chest drainage when it is used in patients with pulmonary resection. One comparative study of the use of this technology in patients with spontaneous pneumothorax was identified and it showed shorter drainage time and a shorter length of hospital stay compared to conventional drainage and it could be very useful in some outpatient cases. Another comparative study shows that de DCD is useful in pleural decortications, and decreases the cases of reoperation due to bleeding, because continuous suction does not allow the accumulation of clots inside the chest. Without a doubt it is a very useful tool in the thoracic surgery that has consolidated and this is why in this review we want to treat some of the most important point of this technique.

INTRODUCTION

Thoracic drainage is the action of emptying out the contents of the pleural cavity such as air, exudates, transudates, blood and some semisolid substances (clots, fibrin, etc.) that can be accumulated as a consequence of surgery, disease or trauma. Conditions that may require chest tube drainage are pleural effusion, pneumothorax, hemothorax and cardiac tamponade [1]. Once the problem is identified, the action of draining a thorax is achieved by means of inserting a chest tube through the thoracic wall of the patient and connecting it to a thoracic drainage system.

Many different types of thoracic systems have been used in the past decades as the Llenthal water seal in 1922. Which then was improved by Howe in 1952 to the 3-bottle water-seal system and later to the current commercial devices used in most hospitals nowadays in the world? Recently the development and use of the digital thoracic drainage systems offer further benefits over conventional systems but are not worldwide yet available [2].

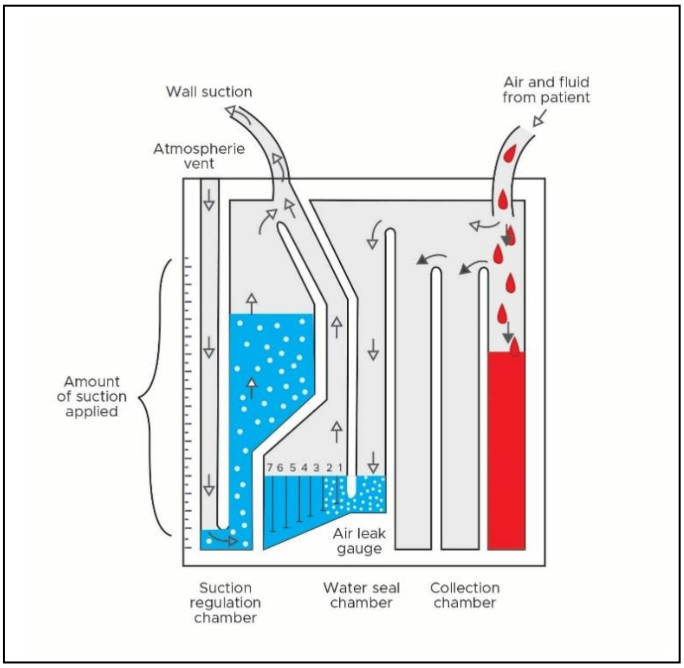
THE CHEST TUBES

Chest tubes, or thoracic catheters, are semi-flexible catheters made in most cases of PVC (Polyvinyl Chloride) or silicone with multiple drainage holes located at one of their sides that typically come in diameters 24 to 40 Fr, in the adult setting, and are transparent to allow visualization of the characteristics of contents being drained. They enter directly into the pleural space and always come sterile. Smaller tubes are capable of draining air and thin liquids, they are related with better tolerance and less pain, while bigger diameters are needed when a purulent exudate, blood or thick liquids are expected [3]. Chest tubes can be inserted in the emergency department, in the operating room or at bedside, always following the principles of the sterile technique [2]. In addition to classic chest tubes, new devices are being created that are capable of better drainage and less thoracic wall and pulmonary trauma such as flexible spiral chest tubes (Redax®, Cardiospiral®). Other instruments like needles, rigid catheters, collecting bags, stopcock valves and connectors can be used to facilitate access and drainage in a short-term setting. The insertion of a chest tube typically occurs in the 2nd, 3rd, 4th or 5th intercostal space in the mid axillary line and once inside it is directed towards the apical region. Located at the 2nd and 3rd spaces it allows drainage of air, while using the 4th and 5th spaces works better for drainage of air and liquids at the same time.

THE THORACIC DRAINAGE SYSTEM

Classic systems consist of three chambers, each one with a different function. The chest tube connects directly to the *collection chamber*; the purpose of this chamber is to collect and temporarily store the drained fluid from the pleural cavity and measure it as it has a graduated grill on its side. On its surface there is an area designed for labeling the date at which the drainage system was placed, name of the patient, and other information. This chamber is usually located on the right side of the system and is a see-through space where the evacuated contents can be seen by the nurse or physician [4]. The *water-seal chamber* consists of a water-made one-way valve that allows air inside the pleural cavity to enter into the system but blocks the passage of air on its way back to the chest tube and the thorax. It needs to be filled with 2 cm of water to ensure correct operation of the water-seal, missing this will lead to loss of the water-seal function of the chamber. The water in this chamber, when the chest tube is properly placed, creates a phenomenon called "tidaling" which consists in the rise of the level of water with inhalation and the drop of the level with exhalation. Tidaling indicates proper location and functioning of the chest tube inside the pleural space. In this chamber a persistent bubbling (or an intense one) indicates an air leak, the higher the bubbling the higher the leak but no precise measure can be done in a classic system. In newer systems such as Topaz Medela® a digital register of the amount of leak is possible [5].

The third section of the system is called the *Wet / Dry suction control chamber*. This chamber is responsible for controlling the amount of suction delivered to the pleural space; this chamber controls it and not the suction source. Typically set at a negative pressure of -10 to -20 cm for the first 12 to 24 hours in an adult, then diminished as needed. Commercial systems usually allow the user to set the negative pressure in a range of 0 to -40 cm H_2O. The initial negative pressure selected depends upon indication. For spontaneous pneumothorax the least amount of negative pressure possible or no negative pressure at all is recommended, so beginning with 0 pressures and increasing if pneumothorax persists is a good strategy. For draining fluid an initial -20 cm H_2O is a reasonable at start point and increments would be guided by routine chest radiographs. All cases should be individualized, and continuous monitoring is imperative. In proper operations a continuous gentle bubbling should be seen in this chamber. The dry suction system uses a self-controlled regulator.



DIGITAL THORACIC DRAINAGE SYSTEMS

Digital Thoracic Drainage Systems (DTDS) are the newest type of drainage systems and offer special advantages over the classic systems. They eliminate the differences between observers. These systems have been related in case series to earlier withdrawal of the chest tube and early hospital discharge thanks to the objective data offered in air leaks [6,7]. Since the time they are attached to the chest tube and turned on an immediate real-time quantification of the air leak is seen on screen, the amount of leak is recorded and shown to the operator in absolute values or in a chart. The DTDS accomplish the same principles of collecting, creating a one-way seal and delivering negative pressure to the pleural cavity, but all these features are electronically set and controlled. They are also equipped with a battery, so that continuous suction is possible when transferring the patient between different areas inside the hospital and in the case of Thopaz Medela® an obstruction alarm has been added so that no delays in recognition of this complication are made. Their ease of use and the only requirement of an energy source to deliver suction make them a great option for outpatient management in cases of prolonged air leak, defined as an air leak persisting after postoperative day 5 [8].

CHEST TUBE REMOVAL

Criteria used to determine the time at which the chest tube can be removed is based on the following. For chest tube to be removed after treating a pneumothorax an absence of air leak must be present, seen in the water seal chamber as absence of bubbling, and if the suction is removed no air should accumulate in the pleural cavity. In other words, the cause of the pneumothorax must be solved [9]. One common behavior is clamping the tube to simulate the action of tube removal before actual removal of the tube itself, this practice is not needed, and if done, it must be carefully monitored because the associated risk of developing a tension pneumothorax. If the treated condition was an effusion the lung must be adequately expanded and daily output should be between 100-300 mL/day in adults. Nevertheless, recent studies address that no specific threshold has been validated and those cases must be individualized [10]. In cases of empyema pockets of fluid that are created that are inaccessible to the tube but if patient is stable and with no signs of sepsis tube may be removed and those small collections expected to resolve on antibiotic therapy.

CONCLUSION

Thoracic drainage is a well standardized procedure and becomes a central maneuver in the treatment of those thoracic conditions that generate a pneumothorax, hemothorax, empyema or a pleural effusion. Knowing the indications, technique, types of tubes and the different thoracic drainage systems is essential for surgeons, emergency room and intensive care unit doctors and nurses, residents and any other professional that may get in touch with a patient with thoracic pathology in their daily practice. Getting to know these devices is not easy and usually requires that the professional familiarizes with them a couple of times before been capable of using them correctly and troubleshooting. Nevertheless, after a short training these systems are simple and very easy to apply. We encourage the students, residents and professionals to get to know the type of thoracic drainage systems that are available at their hospitals and learn their daily management from whom day to day operate these devices.

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