Heimlich valve and pneumothorax

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Abstract: The Heimlich valve is a small one-way valve used for chest drainage that empties into a flexible collection device and prevents return of gases or fluids into the pleural space. The Heimlich valve is less than 13 cm (5 inches) long and facilitates patient ambulation. Currently there are several systems in the market. It can be used in many patients instead of a traditional water seal drainage system. The Heimlich chest drainage valve was developed so that the process of draining the pleural cavity could be accomplished in a safe, relatively simple, and efficient manner. This valve system has replaced the cumbersome underwater drainage bottle system. Moreover; the Heimlich valve system connects to chest tubing and allows fluid and air to pass in one direction only. This system functions in any position, and it does not ever need to be clamped, a regulated suction can be attached to it if necessary. The valve drains into a plastic bag that can be held at any level, allowing the patient undergoing chest drainage to be ambulatory simply by carrying the bag. In the current mini review we will present the Heimlich valve system and method of insertion.

Keywords: Pneumothorax; Heimlich valve; VATS

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First introduced in 1965, the Heimlich flutter valve is a one-way portable device that was designed for use as a drainage procedure in order to avoid the need for intrapleural suction after thoracotomy (1). The inventor of the valve was Henry Heimlich, an American thoracic surgeon who also first described the Heimlich maneuver. Soon, it became very popular in the outpatient management of patients with prolonged air-leakage from various causes (2), and has also been used in emergency treatment of pneumothorax in battle fronts (3).

As already mentioned, it is a one-way valve, thus it prevents the evacuated air from travelling back to the thoracic cavity along the attached chest tube. The valve is made of a plastic case with a rubber sleeve inside. It has two nozzles, the inlet nozzle which allows the air to pass in the valve through the chest drainage tube attached to it, and the outlet nozzle which allows the air to pass to the environment or a collecting device during expiration. The rubber sleeve is attached to the inlet nozzle in such a manner that, during inhalation, it closes off, thus preventing air to be sucked in, through the valve, to the pleural cavity (*Figure 1*). The free end of the rubber sleeve is compressed,

Figure 1 A Heimlich flutter valve.

Figure 2 A Heimlich flutter valve connected to the chest drainage tube at the left chest wall.

so that the two sides remain in contact with each other, in order to achieve this function. When the air passes through the inlet nozzle in the rubber sleeve, the latter one opens allowing the air to escape during expiration. But during inhalation the free end remains closed, due its compression, preventing the air to be sucked back in the thoracic cavity. This way pneumothorax is safely evacuated. By the same mechanism, the Heimlich flutter valve may also facilitate the evacuation of fluid. The inlet nozzle is securely attached to one end of a chest drainage tube, while the other one lies within the patient's pleural cavity. The attachment may be secured with pieces of adhesive tape. The valve is also attached to the patient's chest wall, but care must be taken that the distal end, the outlet nozzle, remains unimpeded (1).

When air passes through the valve, a distinct "flutter" sound can be heard, ensuring that the device is working properly. Absence of the sound accompanied with no movement of the rubber sleeve during placement means that no air passes through the valve, which indicates either the resolution of pneumothorax or possible clogging of the chest tube. Auscultation of the chest or a chest X-ray might be helpful.

The Heimlich flutter valve has some significant advantages compared to under water seal drainage, the most important being its small size and its portability, allowing this way the immediate ambulation of the patient, a very important factor in the successful treatment of pneumothorax (1). It can function in any position and doesn't need clamping (4). It has a small production cost, thus allowing it to be a disposable device, with no need of re-sterilization. Its function is easily understood both by the medical staff and the patient, due to the distinct sound and movement of the rubber sleeve. If there is need for fluid evacuation, the distal end may be attached to a collecting device, e.g., a bag or Bulau device. Also negative pressure or under water suction may be applied to the outlet nozzle if needed (1). The size of the drainage chest tubes that it can be attached to, may vary (small or large calibre tubes) (5). It may be used over a long-term period in cases that air-leakage is persistent and surgical treatment is excluded, allowing the outpatient management of these patients. Full expansion of the lung is indicated by absence of the "flutter" sound and the immobilization of the rubber tube of the valve during breathing and coughing. After full expansion is diagnosed and confirmed, the system (chest tube drainage and valve) may be removed from the patient. Small recurrences of pneumothorax have been described in the literature but they are usually insignificant (*Figure 2*).

Probably the most important thing about the Heimlich flutter valve is that it only functions properly under a specific orientation. This means that if it's connected wrongly at the chest tube drainage it will not function at all. Furthermore, the patient undergoes great risk of developing tension pneumothorax, a very serious complication that may be fatal. If the outlet nozzle is attached to the tube, the rubber sleeve can't open (due to its compression), the air can't be evacuated and is accumulated in the pleural space, sometimes leading in tension pneumothorax. Case reports have been published describing this complication (6-8). For this reason, all the valves have distinct markings on the casing indicating clearly the inlet and outlet nozzles and the proper orientation of the valve during placement, so that reversal of the valve may be avoided.

Care must also be taken during attachment of bags or

other collecting devices in the outlet nozzle, in order to not block the nozzle and prevent the evacuation of air (9). During outpatient management period, frequent inspection of the valve from the medical staff is mandatory.

Another major complication of the Heimlich flutter valve is the increased risk of developing chest empyema (10,11). This occurs through infection of the pleural space, mainly because of the prolonged remaining time of the chest tube drainage and the valve. The placement of the valve needs to be performed under sterile conditions (the valve itself is pre-sterilized) and all the attachments need to be secured and air-tight, in order to avoid further infection. Accidental dislodgements of the valve have been reported in the literature (2). In such case, re-attachment of the valve may be associated with increased risk of infection.

There isn't any reported death in the literature, even in cases of accidental reversal of the valve and the development of tension pneumothorax. This proves that, if used correctly, and if the patient and the medical staff are properly instructed, the Heimlich flutter valve is a safe and efficient procedure for treating pneumothorax.

There is not any specific contraindication for the use of a Heimlich flutter valve in the literature. Relevant contraindications may be large hydro-pneumothorax with large volumes of fluid in the pleural space or thick secretions and blood which may cause occlusion of the rubber tube due to adhesions or clots, preventing the outflow of air (1,8). If such a case occurs, replacement of the valve or under water seal drainage is mandatory.

Studies have proved the safe use, with good results, of the valve in cases of primary pneumothorax treatment (1,12-30) and in many different cases of secondary pneumothorax in patients with Pneumonocystis carinii, AIDS, cystic fibrosis, lung metastases etc. (2,10,31-45).

The technological advances nowadays have allowed the construction of small, portable under water seal drainage devices, which also facilitate the immediate ambulation of the patient after placement and have lesser complications than the Heimlich flutter valve in cases where pneumothorax is accompanied by large volumes of fluid or blood (42,46-58). This has led to limited use of the valve over the recent years, but still holds a place in the outpatient management of patients with prolonged air-leakage, for whom further surgical treatment is not an option.

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