International Journal of Advanced Biotechnology and Research (IJBR)
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-9, Issue-1, 2018, pp25-30
http://www.bipublication.com

Research Article

The invention of Thoracentesis catheter

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ABSTRACT

Introduction: One of the side effects of chest trauma is pneumothorax. Pneumothorax is the accumulation of air in the adjacent space, which leads to lung collapse on one another, and ultimately to interruption in breathing and death. Nearly half of the deaths are due to damage during the first minutes after the injury, and the most important causes of these deaths are chest injuries. The purpose of this device is to reduce mortality, especially in emergency situations.

Material and Method: The need for an appropriate and low-risk tool for the treatment of the above-mentioned complication and the special economic conditions, and the lack of equipment and funding, made us take an effective step, with the invention of a safe, fast and inexpensive way to treat and save the lives of patients and reduce morbidity and mortality, as well as to develop and advance science, both in the pre-hospital environment and in crises and in hospitals.

Discussion: Considering the prevalence of accidents and traumas, especially the chest trauma, as well as pneumothorax, for this purpose, with the aim of a temporary and rapid treatment,pressurizedpneumothorax has been used in pre-hospital and hospital conditions and crisis in other parts of the world for thoracentesis. But the invention of this tool, which is a specialized and unique therapy of pressurized pneumothorax, separates this tool from the rest.

Results: The construction of the catheter thoracentesis system can be effective in controlling pneumothorax and in reducing mortality.

Keywords: Catheter, thoracentesis, pneumothorax

INTRODUCTION:

In the current world, trauma is the main cause of mortality, hospitalization and disability in all age groups. For this reason, today, more work is done on the victims of trauma than those of other diseases (1). Trauma is the main cause of death in patients under 40 years of age (2). There is evidence that about 16,000 deaths occur due to trauma;22% of these cases are due to traffic accidents, and it is estimated that by 2020 trauma (injury) is the third leading cause of death in the world. In Iran, statistics on traffic accidents amount to 2,240 injured per year (3). Of these injuries, 66% of injuries are related to blunt type chest that is associated withhigh mortality (4). Studies have shown that pneumothorax and its resultant mortality are of global scope; and according to the conducted researches, the prevalence of this disease in men (80%) is higher

than in women (20%) (5). On the other hand, pneumothorax is a disorder that may occur in the penile thrombus or chest blunt. And because of its urgency, there is a need for rapid diagnosis and treatment (6).

Types of pneumothorax are as follows:

1- Closed: The air enters the pleural space through a vent in the lining that covers the lung.

2- Open pneumothorax: emerges through the penetrating trauma of the chest, which may result in severe ventilation decrease.In the event of a delay in treatment, death occurs. Open chest damage causes the connection between the adjacent space and the atmosphere. This penetration prevents negative pressure inside the chest and causes the lung to fall on the same side. By changing the flow of blood to a healthy position, ventilation mismatches / blood supplyoccur. And since little oxygen is available for gas exchange, and a wide dead functional space is produced, hypoxia occurs.The air may escape during an exhalation stage, or it may be confined in the adjacent space.Resistance to airflow in the airways may be greater than open wounds, resulting in ineffective respiratory effort. By creating a one-way flow of air and entering it into the chest cavity and not leaving, pressure in the lateral space is increased, which is likely to become a pneumotoric compression so life-threatening situation is ineluctable (5).

3- Pressurizedpneumothorax: is caused when the air enters the lateral space, due to damage to the chest,through the trachea and the bronchus, confines there and cannot be removed. As a result, the mediastinal shift to the healthy lung occurs, which affects healthy lung ventilation, as well as the involved lung. This causes pressure in the space that ultimately the collapse of the lungs (the lungs fall on each other) happens. In this condition, the patient suffers from severe shortness of breath. In addition, due to increased pressure in mediastinum, hypotension also occurs, which worsens the patient's condition instantaneously. But at this stage, the removal of pressure (decompression) can quickly improve the symptoms of the patient. Pressure pneumothorax can be a result of penetrating or non-penetrating traumaand is an immediate life-threatening condition. If immediate treatment does not begin, there may be a rapid reduction in ventilation and a delay in treatment will quickly lead to death. One of the methods used in the emergency treatment of these patients is the use of thoracentesis with needle, although this process can be met with failure and incidence of complications (6).

Pneumothorax is usually diagnosed with a combination of clinical examination and imaging. Standingchest radiography is usually the first diagnostic study to investigate the presence of pneumothorax in patients with trauma. It is vital for diagnosis, but due to concerns about spinal cord injury, hemodynamic instability and loss of consciousness cannot be applicable in all cases. In patients with multiple traumas, standing chest radiography usually occurs in a supine fashion, which may sometimes not be correctly diagnosed. In addition to the simple graph of the chest, CT scan and portable ultrasound are also used in diagnostic methods of pneumothorax (7). Following these complications and the presence of other factors such as the treatmentof pneumothorax includes aspiration with a simple needle, inserting a toracostomy tube, performing thoracotomy or thoracoscopy, resection of the lesion, and sewing the leakage site. In advanced cases, the pleurectomy is performed with the separation of all the perineal pylorus from the lower rib and the interdental muscles (13-8).

MATERIAL AND METHOD:

This tool has been designed as follows: First, choose Angioquate No. 16, consisting of two main parts of needle guide and plastic lumens, and in the needle body (needle guide), a vent is

embedded in the duct (see exhaust air in the catheter) leading to the gray-colored angioquate plastic head (which is commonly used for drug blouses). At the end of the needle guide, there is a flexible rubber section that should be drained for easy exit without air resistance. At the end of the catheter, there is an angiocok lock. A three-way, with a main path and two substrate air outlets, is embedded in the plastic head of the gray-colored angioquette. And these paths are as follows:

1. Main path: is situated at the entrance to the plastic head of the gray anjection and contains the main one-way valve outlet.
2. The first sub-path: contains a one-way valve to enter the water. From this valve, 0.2 cc of water is introduced into the boundary of sub-paths 1 and 2, which produces little bubbles at the time of inserting needle and mixing the air with this water and is a good guide to confirm that the tip of the catheter is in the lateral space.
3. The second sub-path: has a guide pad with a ball, which is surrounded on both sides by a narrow bar. The mobility of this ball due to the air bubble is indicative of air removal from the chest space.

The three ways, along with the fixation of the catheter, are firmly fixed by the fixing piece. The catheter fixing dressing that passes through the needle guide and lumbar blunt is fixed to the fixing piece by liquid glue to a circular plastic piece with a diameter of 8 cm. Needle guide, which is a few millimeters taller than a plastic lumen, is responsible forperforating the skin and interdental muscles and pleura. After punching the layers, it is retracted and eventually exitedand the lumbar blunt resides in the lateral space and drains the air. This plastic lumen is flexible and eliminates the risk of damage to the arteries and viscera. The procedure with this catheter is very simple and can be easily used by trained personnel. In this way, the catheter is inserted along the median line of the second intercostal space, perpendicular to the chest from the third gear. After perforating the skin and passing through the outer and inner intercostal muscles, then it enters the air outlet guide valve. After entering the needle into the lateral space, the air is transported through the needle and from the embedded exit hole, enters the main three-way route, moving towards the main one-way valve. This air is then mixed with a little pre-imported water in the sub-path (which, if unreliable, can be injected from the one-way valve entrance to the water), and creates a little bubbles, whose emergence will indicate the correct placement of the catheter in the adjacent space.In the next, after the insertion of a few more millimeters(this is done because the lumen blunt is about a few millimeters shorter than the needle guide, it also passes through the pleura and situates in its proper position), the needle is completely removed, so that if the volume of the trapped air is too high, it is removed. Then, in order to avoid entering the air from this place into the adjacent space, we close the pathway with needle and fix the catheter in the chest position by the fixing dressing.If the volume of trapped air in the chest is negligible and the air outlet valve does not indicate whether or not air has been removedand also if we do not ensure the correctness of inserting the needle, then we act in this way: we remove the needle lock and connect the 5cc syringe to the end of the catheter and after the perforation of the layers, we aspirate.If the syringe piston is under pressure and continually going backwards, it indicates that the needlehas not entered the adjacent space, or of the lack of air in the adjacent space (lack of pneumothorax); but if the piston can easily go back and return to its original location, it indicates the catheter is in the correct position.After inserting the needle guide for a few millimeters, we remove it, direct the lumen blunt to the end and fix the catheter into the chestand lock the needle to the end of the catheter. In the inventions of the past, similar diagnostic tools (mostly of a vacuum type) had been used, but in this design, with a different diagnostic method, a solution is presented for the rapid diagnosis and treatment of pneumothorax.

RESULTS AND DISCUSSION:

At present, for the temporary treatment of pressurized pneumothorax, especially in the country, the needle syringes or simple catheter is used. In order to confirm the accuracy of needleposition in the adjacent space, it is necessary to use other traditional instruments, such as a bottle of serum, serum kit and other devices; which in addition to being time consuming they require more space for the procedure. Also, the use of the traditional method, especially if it is done by non-specialists, has a lot of legal issues in addition to having complications and the possibility of serious injuries. In spite of many searches, such a unique tool was not found within the country. But in other countries, we have foundsome inventions in this field that that showed that the innovative thoracentesis catheter was different in terms of diagnostic and functional criteria with other tools, some of which are pointed to in below:

Vaccival Thoracentesis Catheter with Negative Pressure was made by John M. Clarke in 1984 with US4447235 A, which is used to treat pleural effusion (fluid accumulation in the adjacent space). The guiding tool for using this tool is to use a syringe to confirm the placement of the catheter in the adjacent space.

The plate-type thoracentesis catheter was made by Frank A. Scarfone and David H. Turkel in 1994, US5300046 A, which is used with the mechanism of creating negative pressure in the peripheral space in the treatment of pleural effusion (fluid accumulation in the adjacent space). The guiding tool for using this tool is to use a syringe to confirm the placement of the catheter in the adjacent space.

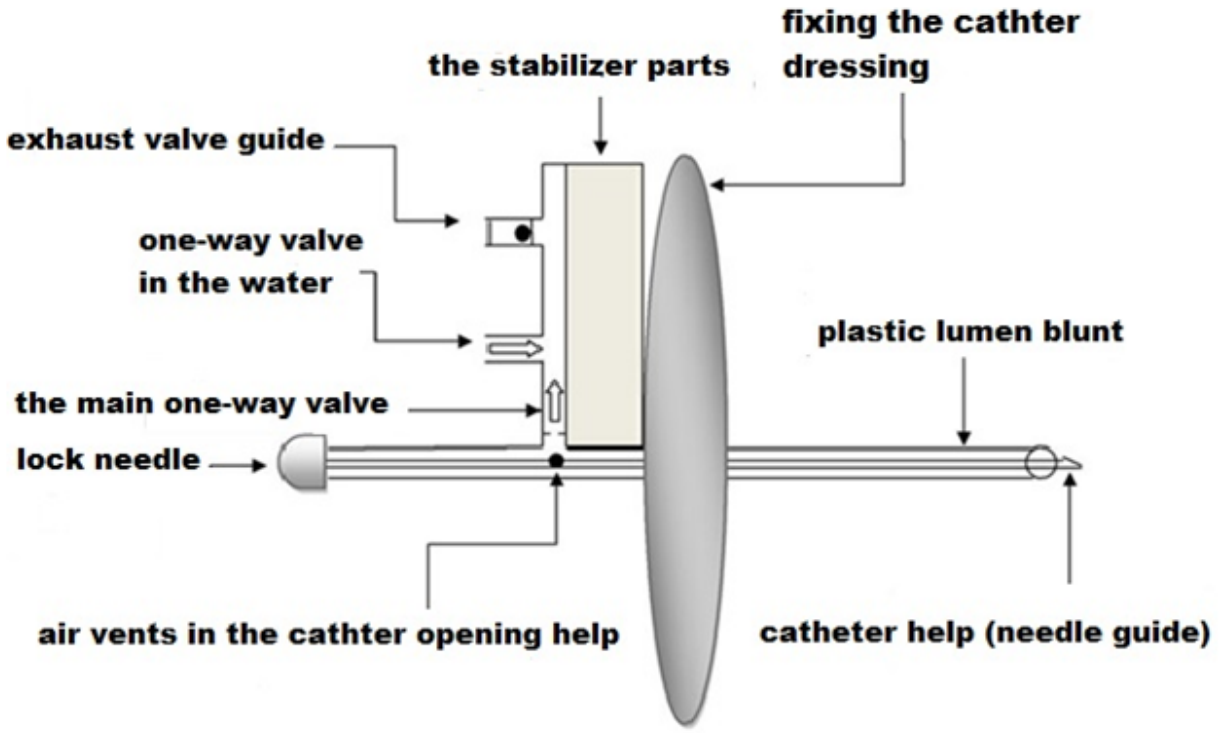
Vaccival Thoracentesis Catheter with Negative Pressure was made by Martin L. Mayse in 2007, US20070282268 A1, which is used in the treatment of pleural effusion (fluid accumulation in the adjacent space) and air evacuation. In this tool, the most important factor in the discharge of the liquid is the source of vacuum (drainage). The guiding tool for using this tool is to use a syringe to confirm the placement of the catheter in the adjacent space.

The three-way drain catheter built in 2012 by Lucio Gibertoni, Andrea Gibertoni, US20120209203 A1, removes the contents of each viscus such as chest, abdomen and bladder drains, through syringe and collecting bag and preserving.

The differences between the inventive thoracentesis catheter and the above-mentioned cases and other tools are:

1- In almost all of the above-mentioned catheters, the syringe is used as a means of confirming the correctness of the catheter in the adjacent space, which has an additional tool for performing the procedure, while in the inventive thoracentesis catheter, the one-way valve (guide) is installed on the tool and is smooth and efficient, with no extra space.
2- In the temporary treatment of pressurized pneumothorax,this device operates without any vacuum system (sucker); therefore, the person's attention is focused on the catheter itself to diagnose and treat.
3- The innovative catheter, in addition to the temporary treatment of pressurized pneumothorax, is also effective in reducing air pressure, in the detection and removal of fluid in the adjacent space (pleural effusion).
4- It has a dressing and is able to be fixed on the chest, which occupies a little space.
5- It is cheaper compared to the other tools.

The most important innovative step of this device is the use of a unique diagnostic method by using innovative guide and its fixing capability, a unique technique for using unilateral air outlets and safety valves, and its versatility.In the rest of the world, some tools have been used for thoracentesis, which have more complex systems and peripheral treatments. But the invention of this tool, which is a specialized and unique therapy of pressurized pneumothorax, separates this tool from the rest.



Acknowledgement

The Research Department of Jahrom University of Medical Sciences, the Development and Technology Center of Jahrom University of Medical Science, other colleagues are deeply thanked for their collaboration in the conduction of the study.

Conflict of Interest: None

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