

Approach of the treatment for pneumothorax

Yong Huang¹, Haidong Huang², Qiang Li², Robert F. Browning³, Scott Parrish³, J. Francis Turner Jr.⁴, Konstantinos Zarogoulidis⁵, Ioanna Kougoumtzi⁶, Georgios Dryllis⁷, Ioannis Kioumis⁵, Georgia Pitsiou⁵, Nikolaos Machairiotis⁸, Nikolaos Katsikogiannis⁶, Nikolaos Courcoutsakis⁹, Athanasios Madesis¹⁰, Konstantinos Diplaris¹⁰, Theodoros Karaikos¹⁰, Paul Zarogoulidis⁴

¹Respiratory Department, Chongqing Zhongshan Hospital, Chongqing 400013, China; ²Department of Respiratory Diseases Shanghai Hospital, II Military University Hospital, Shanghai 200433, China; ³Walter Reed National Military Medical Center, Interventional Pulmonary, Bethesda, MD, USA; ⁴Cancer Treatment Centers of America, Interventional Pulmonary & Critical Care Medicine, Goodyear, AZ, USA; ⁵Pulmonary Department, "G. Papanikolaou" General Hospital, Aristotle University of Thessaloniki, Thessaloniki, Greece; ⁶Surgery Department, University General Hospital of Alexandroupolis, Democritus University of Thrace, Alexandroupolis, Greece; ⁷Hematology Department, "Laiko" University General Hospital, Athens, Greece; ⁸Obstetric - Gynecology Department, "Thriassio" General Hospital of Athens, Athens, Greece; ⁹Radiology Department, University General Hospital of Alexandroupolis, Democritus University of Thrace, Alexandroupolis, Greece; ¹⁰Thoracic Surgery Department, "G. Papanikolaou" General Hospital, Aristotle University of Thessaloniki, Thessaloniki, Greece

Correspondence to: Paul Zarogoulidis, MD, PhD. Pulmonary Department, "G. Papanikolaou" General Hospital, Aristotle University of Thessaloniki, Thessaloniki, Greece. Email: pzarog@hotmail.com.

Abstract: Pneumothorax can occur in several situations such as; chronic obstructive pulmonary disease (COPD) where emphysema is observed or due to a biopsy for malignancy suspicion. In any case it is a dangerous situation that requires immediate attention and treatment. Pneumothorax can be divided in primary and secondary. Staging of pneumothorax is also very important. In our current editorial we summarize etiology and treatment of pneumothorax from a panel of pulmonary physicians, oncologists and thoracic surgeons.

Keywords: Pneumothorax; medical thoracoscopy; intervention

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The treatment principles of pneumothorax include five principles: air elimination, reducing air leakage, healing the pleural fistula, promoting re-expand and preventing future recurrences, but treating underlying diseases, preventing and dealing complications are also important. The core of treatment is based on different etiology and pathogenesis. If patients did not get promptly and completely treatment that were combined with pneumothorax or underlying diseases, respiratory failure would be most dangerous. Therefore maintaining necessary respiratory function and stable hemodynamics are the first step of treatment (1-8).

Air elimination is the first and most important treatment of pneumothorax through needle aspiration and catheter drainage. Their improvements are based on the developments of the material and operation on special positions/circumstances. Needle aspiration is required to

exhaust air completely at the first time. In order to approach the target, aspiration should be done in any position of the chest cavity even in some traditional dangerous positions such as the supraclavicular fossa and subclavicular region, guiding by Ultrasound or CT scanning. Additionally, new damage caused by the needle must be avoided during the re-expansion. The current approach is to use cannula or vine remaining needle, even connected to one-way Heimlich valve device to enhance the efficacy and are convenient for patients to activities. In the future there may have sensitive detection method or use the non-metallic needle. Secondary pneumothorax patients especially with pre-existing structuredness lung diseases such as chronic obstructive pulmonary disease (COPD) or tuberculosis, needle aspiration treatment success rate is generally low (9-15).

Catheter drainage is the same with the aspiration

which requires to be done in majority available positions. Moreover, easy-safe operation, less painful, effective drainage and fewer catheter blocked are requested. There are seemed conflicting. "Effective drainage and fewer catheter blocked" require a larger, harder and more holes catheter. On the other hand it is the reason of the difficulty of catheter placement and post-operative pain. Currently, disposable catheters with their supporting catheter needle are used commonly for example smaller-bore pigtail catheter which can be connected with Heimlich valve. The advantages of these catheters are their material and porous body which are uneasy to be folded, distorted, extruded and blocked. Owing to their characters they can be used in some dangerous areas for local pneumothorax drainage. More and more trials have suggested that smaller-bore catheter drainage would be not less effective than larger-bore one, then the smaller is simple, safe, minimally invasive, less painfulness, fewer complications, faster recovery and cost savings. However the diameter shouldn't be too small, generally 8~10 F or 10~12 G, 14 F is the largest. Traumatic pneumothorax may require the placement of a larger-bore chest tube (15-25).

In the recommendation of British Thoracic Society pneumothorax guideline 2010, needle (14~16 G) aspiration is as effective as large-bore (>20 F) chest drains. But if failed, needle aspiration should not be repeated and small-bore (<14 F) chest drains may be a good replacement. On the other side, small-bore chest drains should be the first choice, especially for the patients with pre-existing structuredness lung diseases.

The distal drainage device includes water seal bottle and negative pressure suction device. There has no special improvement of water seal drainage bottle and it can collect drainage fluid or connect drainage bottle and negative pressure regulator integrated together. There is another trend: more precise negative pressure regulation. Continuous negative pressure suction still exits some controversy, then "appropriate" negative pressure suction can not only accelerate the air evacuation and pleural fistula healing, but also avoid catheter obstruction that caused by pleural adhesive or fibrous bands. If persistent air leak or incomplete re-expansion exists, negative pressure suction should be taken into consideration. At present, it tends to high-volume low-pressure suction system and the general pressure regulator within the range 5-20 cm H₂O. Re-expansion pulmonary edema is the most dangerous complication but rare.

In addition to artificial pneumothorax without visceral

pleura fistula, clamped observation may be necessary before the extubation. The ACCP consensus group suggests that the tube should be clamped for approximately 4 hours in primary spontaneous pneumothorax and 5-12 hours in secondary spontaneous pneumothorax. The time is so short but there has some doubts about why BTS 2010 guideline was not refer to clamped observation (15-25).

Persistent air leak must be controlled. The main treatment is to block the crevasse of visceral pleura by using titanium clips, endoscopic linear stapling device, biological glue or other adhesive materials. But apart from that, removing away or repairing the damaged parts are available. These operations are completed during surgery or thoracoscope. However, surgical indications are differed from country to country. Those patients who have undesired results, high recurrences, life-threatening and complex pathology mechanism are inclined to surgery. With technological development, video- assisted thoracoscopic surgery (VATS) and medical thoracoscope just has less difference, for instance there is a tendency of thoracoscopic surgery to prefer least injuring of the organism. Another way is to use needlescopic video thoracoscope (25-35).

Another way to reduce air leakage is the endobronchial operation, the approach is relatively cumbersome but be appropriate for intractable pneumothorax. The first step is to find the lung lobe or segment interlinked pleural fistula by using blocking balloon to observe bubbles overflow in the drainage bottle, pressure change or not which can use Chartis system. Without structuredness lung disease or thoracic surgery or trauma, upper lobe is the most likely position of breach and may be treated preliminarily. And CT scanning is needed to infer the possible segment by the image of bulla and adhering band.

There are some methods in common between endobronchial blocking and medical lung volume reduction. One-way valve or autoblood may be used as blocking materials. During the operation, an entire lobe especially upper lobe must be blocked completely. If not, a new pneumothorax would come into being by increased sharply ventilation in other segments. More attention should be paid, if the plugging is effective.

The basic method of healing crevasse is complete lung re-expansion which means making two layers of pleura fit together. And the methods are mentioned before. External force is available too, such as blocking the breach directly from the rupture of the visceral pleura as previously mentioned.

Lung re-expansion and air exhausting almost

simultaneously, but in order to maintain the re-expand, air leakage reducing and crevasse healing is needed. As the three basic treatments had been done, deep breath, coughing and functional exercise can also help to lung re-expansion. If sputum results in atelectasis, bronchoscopic suctioning is needed to promote the airway clearance (25-35).

Except traumatic or iatrogenic factors, pneumothorax usually is also a recurrent disease, especially caused by structuredness lung diseases which named secondary pneumothorax. Some studies revealed its recurrence rate 70% or more. Therefore, to prevent recurrences is other important aspect of the treatment principles. Surgery is more effective due to its thorough resection and patches, even to vicinal bullae, blebs, emphysema-like changes or pleural porosities. In spite of larger surgical trauma, open thoracotomy and pleurectomy have the lowest recurrence rate (approximately 1%). However, if the patient needs a surgery, he should first be evaluated whether VATS is suitable or not. Although the recurrence rate increased slightly (approximately 5%), it would get more clinical benefits, especially for the patients with worse condition. Fluorescein-enhanced autofluorescence thoracoscopy (FEAT) may reveal more potential pleural abnormalities as the direction of subsequent operation.

Pleurodesis usually be taken on the patients with intractable or recurrence pneumothorax and has become a standard step of thoracoscopic or surgical procedures. No matter which kind of pleurodesis, pleural abrasion or chemical pleurodesis are expected to be adhered as evenly as possible to the entire pleural cavity. And medical chemical pleurodesis would fit to inoperable patients. To close the entire pleural cavity is to use the talc (no more than 5 g sterile asbestos-free talc by slurry or poudrage), or other sclerosants resulting in aseptic inflammation. Besides medical thoracoscope, needle or chest tube may be alternative pathways.

Smoking cessation, persistent respiratory function exercise, proper breathing exercise, and expectoration training, are also means of reducing pneumothorax recurrence, especially for patients with underlying structuredness lung disease. Recently, there have some surgeons who are attempting to reinforce visceral pleura. Strengthening of the endangered visceral pleura parts with absorbable polymers may prevent the development of new subpleural blisters or emphysema bullae responsible for the disease recurrence (32,35-40).

The complications of pneumothorax include effusion, hemorrhage, empyema; respiratory failure, pneumomediastinum, arrhythmias and instable hemodynamics need to be handled

accordingly. Treatment complications refer to major pain, subcutaneous emphysema, bleeding and infection, rare re-expansion pulmonary edema. Skilled and standardized treatment is the key to prevent and reduce the complications (32,35-40).

As for the treatment, some countries have promulgated guidelines successively. Although therapeutic methods are roughly the same, several specific selection and evaluation criteria is different even conflicting. Moreover, there are also obvious differences in doctor compliance to the guidelines. The factors that influence the choice can be simply attributed to the severity of symptoms, treatment difficulty/convenience and the likelihood of future recurrence. The main factors as follows:

- (I) Age and general condition: the patients who are elder than 60 or worse than ectomorphic body type are more likely to relapse and have a worse tolerance to surgery.
- (II) Smoking history: smokers are more likely to relapse and are prone to the complications and sequelae.
- (III) Underlying diseases and special conditions: the patients with COPD, bronchiectasis, tuberculosis, cystic fibrosis, interstitial lung diseases, AIDS, etc. Ventilating patients and pregnant women would be also paid more attentions.
- (IV) Initial or recurrent pneumothorax: the latter requires more aggressive treatment, including pleurodesis.
- (V) Symptoms: extents of breathlessness and respiratory distress are the most two important standards. If accompanied with the decreased oxygen saturation and instable hemodynamics, the patients must be treated actively and promptly.
- (VI) The size of the pneumothorax: less important than the typical symptoms. Main guidelines simply distinguished small or large size, based on the two distances of the visceral pleural surface from the chest wall on the conventional X-ray. Expiration chest radiograph may show more information. CT scanning and lung ultrasonography have been used wildly and got more attention.
- (VII) The special types of pneumothorax: such as tension, bilateral or catamenial pneumothorax.
- (VIII) The time of pneumothorax: with the duration increased, the more difficult of re-expansion would be. Lung re-expansion quickly in a short time may lead greater possibility of re-expansion

pulmonary edema.

- (IX) Patients' willingness is also the most important factor.

In general, the patients with complex conditions often need earlier and more aggressive treatment, or even earlier surgical referral. But initial oxygen supply and necessary observation (except first aid) would be allowed.

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