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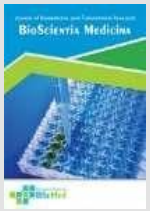

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Management of Extensive Subcutaneous Emphysema with Blow Hole Infraclavicular Incision and Continuous Suction Installation

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A B S T R A C T

Background: Subcutaneous emphysema often occurs in cases of implanted pneumothorax chest tubes and must always be evaluated. Subcutaneous emphysema is a condition where air or gas is found in the tissue under the skin. **Case presentation:** A 49-year-old man was treated for sudden shortness of breath that occurred after a violent cough accompanied by pain and heaviness in the chest area 1 day before admission to the hospital. The patient had previously received anti-tuberculosis drug treatment for 6 months based on chest X-ray results in 2022, and the patient had undergone a rapid molecular test (TCM) examination, mycobacterium tuberculosis (Mtb), and obtained Mtb results not detected. Lung auscultation obtains sound intensity breath weakness until it disappears in both lung fields. Palpation of the skin revealed widespread crepitus on the face, neck, upper extremities, back, chest, and abdomen. The range of motion areas of the neck, shoulders, and hands are limited due to pain with movement. Evaluation of the chest tube obtained: the chest tube was installed in the anterior axillary line on the right at the level of the 5th intercostal space with number 10 attached to the chest wall and the chest tube well fixed to the chest wall. The end chest tube has been connected to the WSD bottle, and evaluation of the WSD shows that there are undulations and bubbles. **Conclusion:** The patient was admitted with spontaneous pneumothorax secondary to tuberculosis and was implanted with a chest tube.

1. Introduction

Subcutaneous emphysema occurs when air or gas enters the subcutaneous layer beneath the skin and soft tissue.[1] Air expansion can involve subcutaneous tissue and deeper tissue in more advanced subcutaneous emphysema.[2] Subcutaneous emphysema can be caused by various conditions such as trauma infection and is a frequent complication in pneumothorax patients with chest tubes attached. Subcutaneous emphysema is also often a sign or indication of malfunctioning chest tubes, such as clogged, folded, or loose. Chest tubes that are not connected with continuous suction and small ones may need to be replaced or even exchanged if the amount of air leakage is large enough.[1] Mechanisms of subcutaneous emphysema in patients with attached pneumothorax chest tubes can occur due to tearing of the parietal pleura, which results in the formation of a pathway for air to enter the subcutaneous tissue.[3]

Mild subcutaneous emphysema does not cause significant symptoms, so management is sufficient with observation; however, in cases with widespread and rapid spread of air, it can be fatal. Extensive and massive subcutaneous emphysema can result in compartment syndrome, disrupt the development of the chest wall, and result in tissue necrosis. Pressure on the trachea disrupts the respiratory system and can be fatal, requiring intervention.[2] Other studies

found a longer treatment period of 6 days and a higher mortality rate (11%) in patients with pneumothorax accompanied by emphysema subcutis compared to cases without subcutaneous emphysema.[4]

Management of the causes or precipitating factors of subcutaneous emphysema must be prioritized because it can help with gradual resolution. Currently, there are no recommendations for the management of subcutaneous emphysema, which is based on serial case reports and several literature reviews. Studies have written in the literature several methods for managing extensive subcutaneous emphysema, and there is no management method that is superior in managing extensive subcutaneous emphysema because no randomized studies have been carried out.[5] Method selection can be done according to patient factors and clinician preferences. Incision infra clavicle, subcutaneous drainage, and improved suction on the chest tube installed can provide adequate improvement of subcutaneous emphysema.[3,5]

This case report discusses the causes, degree, and management of extensive subcutaneous emphysema that occurred in a patient with a pneumothorax that had been installed. A chest tube is a large size (large bore) using the infraclavicular incision technique blow hole and connect chest tube with digital dry drainage, which is connected to continuous suction to speed resolution of pneumothorax and subcutaneous emphysema.

2. Case Presentation

A 49-year-old man was consulted from the pulmonary ward with complaints of increasing shortness of breath accompanied by swelling in the face, neck, upper extremities, back, chest, and stomach. Patients also complain of difficulty closing their eyelids, difficulty speaking, hoarseness, pain, and discomfort in swollen areas of the body, especially when moving. Complaints are felt to arise after the end of the tube is on the bottled water seal drainage (WSD) is released accidentally when the patient changes position during sleep. The patient was admitted to the pulmonary ward with spontaneous pneumothorax secondary to tuberculosis and had a chest tube size 28 French 3rd day when consulted.

The patient was treated for sudden shortness of breath that appeared after a violent cough accompanied by pain and heaviness in the chest area 1 day before entering the hospital. Shortness of breath does not decrease and increases with activity. There were no complaints of coughing, coughing up blood, fever, weight loss and night sweats. There was no history of trauma or previous medical procedures. The patient had previously received anti-tuberculosis drug treatment for 6 months based on the results of a chest X-ray in 2022, and the patient had undergone tests of fast molecular (TCM)mycobacterium tuberculosis (Mtb) and obtained Mtb results not detected.

The patient appeared restless with cooperative compensatory consciousness, blood pressure 150/70 mmHg, pulse rate 110x/minute and respiratory rate 28x/minute, and a decrease in oxygen saturation of 93% free air, increased by 98% with oxygen supplementation of 5 liters/minute via nasal cannula. A physical examination of the eye was obtained for edema palpebral and lagophthalmos 2 mm in both eyes. Lung auscultation obtained sound intensity breath weakens until it disappears in both lung fields. Palpation of the skin revealed widespread crepitus on the face, neck, upper extremities, back, chest, and abdomen. The range of motion areas of the neck, shoulders, and hands are limited due to pain with movement. Evaluation of the chest tube obtained: the chest tube was installed in the anterior axillary line on the right at the level of the 5th intercostal space with number 10 attached to the chest wall and the chest tube well fixed to the chest wall. The end chest tube has been connected to the WSD bottle, and evaluation of the WSD shows that there are undulations and bubbles.

The patient was admitted with spontaneous pneumothorax secondary to tuberculosis and was implanted with a chest tube on the second day with chest X-ray before and after the instillation chest tube, as in Figure 1. Chest X-ray before installation of chest

tube showed avascular hyper lucency in the right hemithorax with fibrosis of both lung fields, especially at both apexes. Chest X-ray after installation of chest tube: A radiolucent image appears in the soft tissue around the insertion area of the chest tube with minimal effects of subcutaneous emphysema.

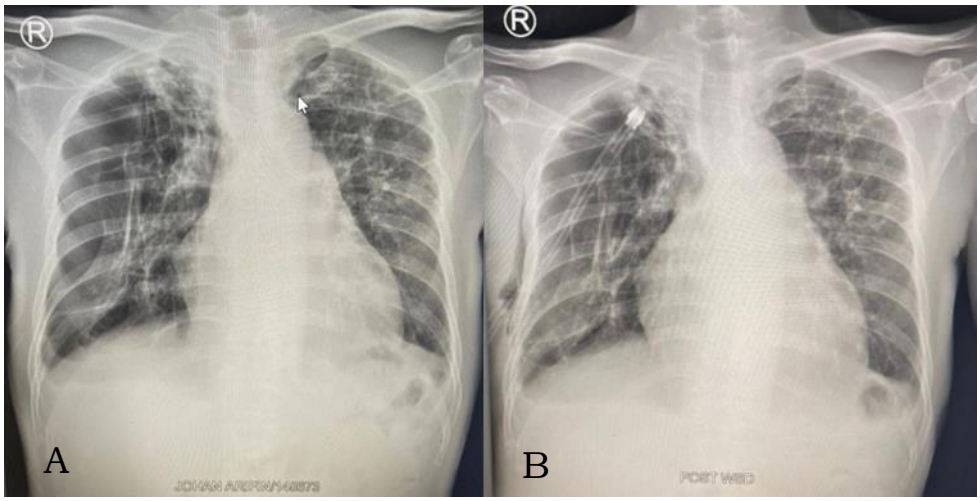

Figure 1. Chest X-ray before and after instillation of chest tube; A. Chest X-ray before chest tube placement. B. Chest X-ray after chest tube insertion shows minimal lucency in the soft tissue of the chest tube insertion area.

The patient underwent another chest X-ray after being consulted. The patient complained of increasing shortness of breath accompanied by extensive swelling, as in Figure 2.

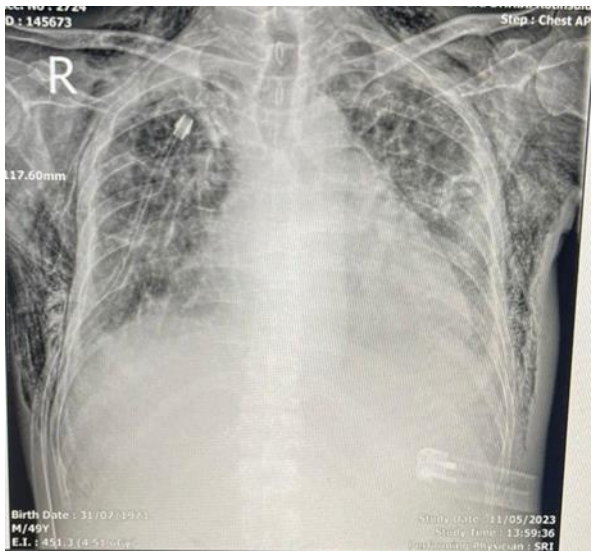

Figure 2. Chest X-ray with extensive subcutaneous emphysema.

A repeat chest X-ray showed extensive subcutaneous emphysema with radiolucent images in the soft tissue of the neck and thorax area that formed a pattern of ginkgo leaf sign. The degree of subcutaneous emphysema is extensive, with a severity level of grade 5. The treatment carried out in this case is by making an infraclavicular incision/incision. blow holes on both sides, as in Figure 3, and providing supportive therapy with oxygen supplementation. The patient's family is educated to perform local massages

on the skin themselves to help evacuate the air, which is indicated by the sound of air coming out accompanied by air bubbles at the incision site.

The end chest tube is connected to Thopaz+, which is a digital drainage system with a continuous suction pressure of -15 cmHg. Evaluation is carried out by monitoring clinical symptoms, evaluating swelling by marking crepitus limits, carrying out examinations on chest tube, fixation, and adequate WSD bottles, as well as quantities of air leak on the Thopaz tool. Complaints of shortness of breath decreased immediately after oxygen supplementation, infraclavicular incision, and connections to the chest tube with continuous suction. Swelling and pain in the face, neck, hands, chest, and stomach decreased less than 12 hours after treatment was carried out, while complaints of hoarseness decreased over time and gradually improved on the 4th day after subcutaneous emphysema treatment.

Figure 3. Infraclavicular incision blow hole at the midclavicular line at the level of the third intercostal space.

The evaluation chest X-ray showed an impression of improvement compared to the previous chest X-ray, and there was resolution of the subcutaneous emphysema with the absence of a radiolucent image in the soft tissue, as in Figure 4.

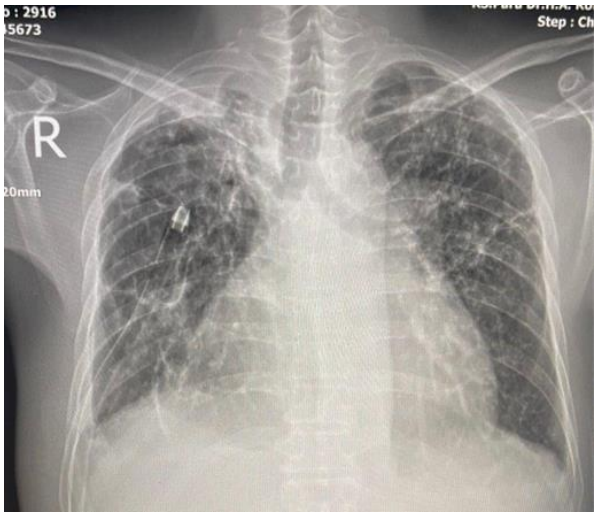

Figure 4. Chest X-ray evaluation on 4th day after blow hole infraclavicular incision.

The patient experienced clinical improvement. Vital signs were within normal limits, and lung auscultation examination revealed bronchovesicular breath sounds, no rales, and wheezing in both lungs. Inspection The chest tube was installed in the right axillary anterior line at the level of the 5th intercostal space with number 10 attached to the chest wall, fixed to the chest wall well, and the end of the tube has been connected to Thopaz+. The Thopaz+ monitor screen shows an air leak flow of 0 ml/min, which will activate the check feature chest tube and confirm the absence of blockages. The pressure in thopaz+ is changed to approach physiological pressure, namely - 5 mmHg.

3. Discussion

A case of subcutaneous emphysema was reported in a 49-year-old man who was consulted from the pulmonary ward. Free air infiltration beneath the subcutaneous tissue is known as subcutaneous emphysema. The incidence of subcutaneous emphysema ranges from 0.43% to 2.34%. A study conducted over 10 years looked at the average age of subcutaneous emphysema patients, namely between 53 ± 14 years old, with 71% of them male.[1] Subcutaneous emphysema can be caused by trauma, infection, or malignancy, occur spontaneously, and can also occur as a result of complications of medical procedures such as surgical implantation chest tube.[6,7] The incidence of subcutaneous emphysema in patients with pneumothorax is reported to occur in 15-20% of patients who underwent drainage with chest tubes.[7] This case report is about subcutaneous emphysema in a patient with an implanted pneumothorax chest tube on the 3rd day.

Other medical procedures other than those related to the installation of chest tubes, which are reported to be available, result. Subcutaneous emphysema is a medical thoracoscopy procedure that is reported in approximately 7% of laparoscopic procedures with an incidence rate of 77% even though it is not detected clinically.[8] Barotrauma in patients on mechanical ventilation can also experience subcutaneous emphysema ranging from 3 to 10% depending on the medical indication for intubation.[9] Injury to the trachea due to endotracheal intubation has also been reported with an estimated incidence of 0.05% resulting in subcutaneous emphysema although this is a rare case, the risk increases with the use of an endotracheal double lumen, emergency intubation, and tracheostomy resultedLarge amounts of air can enter the subcutaneous layer.[10]

Non-extensive subcutaneous emphysema is a common complication self-limited by the installation of chest tubes. Subcutaneous emphysema in a plugged pneumothorax patient's chest tube can be a sign of a functional disorder chest tube, such as being blocked, pinched, or loose. The chest tube should be evaluated to determine whether it should be repositioned or replaced in cases of large air leaks.[1] This case report reports a case of extensive subcutaneous emphysema in a patient with a plugged pneumothorax chest tube with a size of 28 Fr (large bore) and the appearance of extensive subcutaneous emphysema after detachment of the tip chest tube from a WSD bottle. Subcutaneous emphysema in the patient's attached chest tube can occur as a result of discontinuity of the parietal pleura, which forms a direct pathway for air to enter the subcutaneous layer.[7] Subcutaneous emphysema that appears in patients with chest tube indicates 3 possibilities, namely, holes at the end chest tube are not intrapleural, so it can cause air to enter the chest wall tissue, the chest tube is blocked, and another possibility is that the drainage system is unable to drain the air leak (chest tube size that is too small or massive air leak).[4]

The mechanism of subcutaneous emphysema in a plugged pneumothorax patient chest tube that is, the volume of air that passes through the parietal pleura from the intrapleural to the subcutaneous layer exceeds the volume of air expelled from the intrapleural out through the chest tube. Air flow rate imbalance between the tear in the parietal pleura and the drainage through the chest tube. This may occur due to the size of the chest tube or functional disturbances such as blockage, pinching, or

detachment of the chest tube.[7] Chest tube Blockage is a form of imbalance in air flow rate. The study was conducted on 125 attached patients' chest tubes. There were 25 cases with subcutaneous emphysema related to trauma, fistula bronchopleural, extensive and bilateral pneumothorax, use of mechanical ventilation, malfunctioning chest tube, migration side-port, and used small-bore chest tube. Installation of chest tube recurrence can also increase the risk of subcutaneous emphysema.[4]

The principle of management of subcutaneous emphysema is mainly to control the source of air entry into the subcutaneous layer. Management of the causes or precipitating factors of subcutaneous emphysema must be prioritized because it can help with gradual resolution. Subcutaneous emphysema will generally improve within 24 hours, and the air will be absorbed by the surrounding tissue gradually, but the difference in time needed for resolution depends on the cause and extent of the subcutaneous emphysema, treatment of the source of air entry and the choice of treatment for evacuating trapped air.[1,2,12]

The general mechanism of subcutaneous emphysema in patients is an installed chest tube. That is, the volume of airflow that passes through the parietal pleura from the intrapleural to the subcutaneous tissue exceeds the volume of air expelled from the intrapleural to the installed drainage. Unbalanced airflow can occur due to larger parietal pleural tears, small drainage installed, use of positive pressure ventilation, installation of chest tube, as well as air flow interruptions chest tube such as clogged, folded, or loose.[11] A case series on subcutaneous emphysema reports the main cause of subcutaneous emphysema after implantation chest tube is a disturbance in the chest tube and the drainage system.[4] The initial treatment in this case report is to identify the cause of subcutaneous emphysema, which often occurs in the attached patient's chest tube, namely by evaluating and correcting problems in the chest tube and drainage.

Management of subcutaneous emphysema can be done with observation, supportive therapy, and minimally invasive intervention, and requires emergency surgery, depending on the severity. Management of subcutaneous emphysema is generally conservative, but in severe conditions, it requires special treatment. Mild degrees of subcutaneous emphysema do not cause significant symptoms, so management requires just observation. Resolution of subcutaneous emphysema can occur in less than 10 days if the source of the air leak can be controlled. Interventional measures can be performed only in cases of extensive subcutaneous emphysema, including multiple subcutaneous drainage, infra-clavicular incision, use of suction on chest drain, to emergency tracheostomy. The choice of intervention can be considered according to the patient's condition and severity and the patient's preferences.[6]

Assessment of suspected airway compromise (impending airway compromise), such as progressive dysphonia to stridor, must be carried out in the initial management of subcutaneous emphysema because patients at this stage must be given oxygen supplementation.[6,7,12] High-concentration oxygen therapy works by the mechanism of nitrogen washout and diffusion of concomitant gas particles to accelerate the resolution of subcutaneous emphysema. Apart from being recommended as a treatment for pneumothorax, giving a high fraction of oxygen has also been proven to provide benefits in the management of subcutaneous emphysema with the same mechanism of action.[2] The patient, in this case, had a hoarse voice and decreased oxygen saturation, so the patient was given low-flow oxygen supplementation using a nasal cannula at 5 liters/minute. Low-flow oxygen supplementation can be considered because high-flow oxygen administration (positive pressure ventilation) can result in pneumothorax and emphysema through the air leak mechanism.[13,14]

The patient, in this case, reports a case of extensive subcutaneous emphysema. The patient underwent an infraclavicular incision blow holes. The infraclavicular incision is a direct decompression action by making an incision in the skin called a blow hole. There are

several reports in the literature of cases of subcutaneous emphysema that did not improve with drainage via an intravenous catheter. This procedure can improve. An incision is made with a length of 2–4 cm to the depth of the extra-thoracic fascia at the midclavicular line between the clavicle and mammary papilla, unilaterally or bilaterally.[6,7] Report on infraclavicular incision blow holes, namely serial case reports on patients intensive care unit by David Herlan et al. In this report, it was found that resolution of subcutaneous emphysema was faster with an average resolution time of 2 – 4 days.[15,16]

Management of subcutaneous emphysema in pneumothorax patients can be done with the installation of a chest tube (>28 F) with precise position and depth; the tip of the chest tube must be intrapleural, and the WSD functions well. The standard procedure that can be taken to prevent air from entering and accumulating in the subcutaneous layer is to ensure chest tube and the WSD are adequate to evacuate air.[12] Airflow on chest tube subcutaneous emphysema patients with pneumothorax must also be ensured higher and smoother to reduce airflow to the subcutaneous layer. The fanning equation uses a chest tube of size to increase airflow out through the chest tube, where the flow rate is proportional to the length of the radius of the tube passing through it.[17-19] Case reports suggest exchanging a small chest tube for a large one to increase total airflow. Patients with subcutaneous emphysema that is difficult to resolve are reported to be replaced with chest tubes. Large sizes have better results compared to connections with negative pressure.[19,20]

The patient, in this case, has an end chest tube connected to Thopaz+, which is a digital drainage system with continuous suction and sets the pressure to -15 cmHg. A research survey in the UK found that in the management of cases of subcutaneous emphysema with attached chest tube pressure can be applied suction ranges from -0.5kPa to -5kPa.[1] Pressure value suction on chest tube There is no consensus yet, but the literature states that the pressure that can be applied is in the range of -5 to -51 cm H_20.[11,20] Comparative study in the assessment of efficacy and safety at various stress levels suction for cases of subcutaneous emphysema has never been done. The danger of using suction, which is connected to the chest tube, is rarely reported, but there is one case report of pulmonary infarction during the use of suction, which is very negative.[3,7] Bilateral infraclavicular incision with the use chest tube large measure connected with continuous suction In this case, it provided a clinical improvement response in less than 12 hours in extensive subcutaneous emphysema, and overall resolution and evidenced by an evaluation chest X-ray showed that there were no clear images in the soft tissue.

4. Conclusion

Management of subcutaneous emphysema cases is chosen according to the condition and extent of subcutaneous emphysema. Intervention measures are carried out in extensive subcutaneous emphysema and/or cases that have disrupted the cardiorespiratory system. The basic principle of treating widespread subcutaneous emphysema is pressure decompression thoracic inlet to ensure that there is little pressure on the airway and blood vessels. Intervention measures that can be carried out in cases of subcutaneous emphysema are multiple subcutaneous drainages, incisions in the infraclavicular blow hole, and the use of suction on the chest drain. The time required for repair of subcutaneous emphysema is very dependent on the extent of the subcutaneous emphysema, treatment of the source of air entry, and the choice of procedure to evacuate trapped air.

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