CONSERVATIVE MANAGEMENT OF SUBCUTANEOUS EMPHYSEMA : A CASE SERIES

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Abstract

Subcutaneous emphysema is a condition characterized by the presence of air within the tissues beneath the skin, particularly in the chest wall, neck, and other areas of the body. It can occur due to various reasons, including surgical procedures, traumatic injuries to the thoracic cavity, neck, and sinus cavities, infections, or spontaneously. Although subcutaneous emphysema often presents with mild symptoms, it can occasionally become severe and pose a life-threatening risk.

Two cases were observed involving subcutaneous emphysema. The first case involved a 4-year-old boy who developed this condition after a blunt trauma, with swelling and crepitus detected in the anterior neck. In the second case, a 5-year-old boy experienced subcutaneous emphysema as a complication of a tracheotomy, with swelling and crepitus extending to the anterior chest and back. To address the issue, a decompression procedure was performed by inserting intravenous catheters into the affected tissues and administering broad-spectrum antibiotics. After respective therapy durations of 14 and 12 days, significant improvement was observed in both cases, with minimal residual symptoms remaining

Needle decompression effectively relieves subfascial pressure in subcutaneous emphysema, while antibiotics play a crucial role in preventing infections and reducing mortality. Prompt diagnosis and appropriate management are essential to address this condition and its potential complications. Successful implementation of needle decompression and antibiotic therapy has been observed in relieving symptoms and preventing further issues.

Keywords : antibiotics, head and neck, needle decompression, subcutaneous emphysema

Introduction

Subcutaneous emphysema is a medical condition that occurs when air infiltrates the skin, specifically affecting the soft tissues of the chest wall or neck. This infiltration of air can extend beyond the subcutaneous layer and involve the deeper tissues of the body. Of note, the extent of subcutaneous spread is an important factor to consider in terms of potential clinical deterioration. However, the extravasation of air beyond the subcutaneous tissues can give rise to various complications, including pneumomediastinum, pneumoperitoneum, pneumothorax, and pneumoretroperitoneum. The passage of air from these affected regions takes place through variations in pressure between the intra-alveolar space and the perivascular interstitium, leading to its dissemination across fascial planes and various anatomical structures.[1] This movement of air follows a dynamic process influenced by the pressure differentials within these tissues and their interconnected pathways. This allows the air to traverse to different regions of the body, such as the head, neck, chest, and abdomen. Notably, air tends to accumulate initially in subcutaneous areas with lower tension until the pressure within the tissues increases sufficiently to enable the dissection of air along other planes. This extensive subcutaneous spread can ultimately lead to severe consequences, including respiratory and cardiovascular collapse.[2,3]

Subcutaneous emphysema can manifest as a result of diverse underlying causes, spanning a range of origins including surgical interventions, traumatic incidents, infectious origins, and even spontaneous events. Injuries affecting the thoracic cavity, neck, sinus cavities, facial bones, as well as occurrences like barotrauma, bowel perforation, or pulmonary blebs, are among the prevalent factors associated with the emergence of subcutaneous emphysema. For instance, during a t

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racheotomy procedure, air has the potential to infiltrate the subcutaneous tissue via the soft tissues in the cervical region, leading to the development of subcutaneous emphysema. Similarly, during arthroscopic shoulder surgery, air infiltration may occur through the chest wall. In industrial accidents, air can enter the extremities, leading to subcutaneous emphysema. Additionally, bowel or esophageal perforation, even without concomitant pulmonary injury, can introduce air into the subcutaneous tissue. In addition to the aforementioned causes, there are various other pathways through which air can enter and contribute to the occurrence of subcutaneous emphysema. These include the track created by a tube thoracostomy, incidents related to central venous access procedures, percutaneous or transbronchial lung biopsy procedures, as well as several other scenarios where air can find its way into the subcutaneous tissue.[4,5]

It is important to recognize the potential consequences of subcutaneous emphysema and its underlying causes. Prompt diagnosis and appropriate management strategies are crucial in order to mitigate the associated risks and complications. Understanding the dynamics of air spread and the factors that contribute to extensive subcutaneous distribution can guide healthcare professionals in providing effective treatment interventions. By identifying the sources of air entry and employing appropriate therapeutic measures, such as addressing the underlying cause and managing the spread of air, clinicians can help alleviate symptoms, prevent further complications, and promote patient recovery and well-being[1, 2,3]

While the exact incidence of subcutaneous emphysema in the pediatric age group has not been reported, it is widely acknowledged to be significantly lower compared to the rates observed in the adult population.[4] The etiology of this condition in pediatric patients exhibits some age-related patterns. For example, prepubertal patients often sustain injuries within the home environment, such as striking furniture during falls or experiencing handlebar accidents while cycling. Reports on subcutaneous cervical emphysema frequently involve cases related to maxillofacial and/or cervical traumas, as well as complications arising from surgeries. [5,6]

One of the most prevalent and noticeable indications of subcutaneous emphysema is the swelling that occurs around the neck, which is often accompanied by chest pain. In addition to these primary manifestations, individuals with subcutaneous emphysema may experience a sore throat, discomfort in the neck region, difficulty in swallowing, breathlessness, wheezing, and abdominal distension. These symptoms collectively contribute to the clinical picture of subcutaneous emphysema. When diagnosing this condition, physicians typically rely on a comprehensive physical examination that involves careful palpation and the identification of crepitation, a distinctive crackling sensation or sound produced when air escapes through the tissues. Furthermore, radiological investigations such as X-rays and computed tomography (CT) scans are valuable tools in confirming the presence of air in the affected area. Radiographs often reveal intermittent regions of radiolucency, which give rise to a fluffy appearance along the outer edges of the thoracic and abdominal walls. CT scans offer enhanced visualization, demonstrating the presence of dark pockets within the subcutaneous layer resulting from the accumulation of gas. Notably, the distension or bloating may extend beyond the neck to involve other regions such as the abdomen, chest, and face. In some instances, individuals with subcutaneous emphysema may exhibit palpebral closure, leading to visual distortion, as well as changes in phonation due to compression of the vocal cords. Another noteworthy diagnostic feature is the detection of high-frequency acoustic sounds through the use of a stethoscope on the skin, indicating the presence of subcutaneous emphysema.[6,7,8]

The management of subcutaneous emphysema should begin with efforts to identify the underlying cause of air dissection in the subcutaneous tissues. Various approaches have been described for management, including subcutaneous incisions, needle decompression, drainage procedures, or cervical mediastinotomy. Antibiotics play a crucial role in preventing infections in deep neck spaces or mediastinum, which can arise from salivary contamination. Administering empiric broad-spectrum antibiotics can also be beneficial in cases involving mucosa tears to prevent the development of mediastinitis.[8,9] The study presented two cases of subcutaneous emphysema and described their management at Dr. Hasan Sadikin General Hospital in Bandung.

Cases

A 4-year-old boy was brought to the emergency room of Dr. Hasan Sadikin General Hospital after falling in the toilet and hitting the blunt end of the tub with his neck. He complained of swelling in the neck, which extended to the chest, head, left eye, and both upper arms. Fortunately, he did not experience any breathing difficulties, cough, paralysis, fractures, or hoarseness. Upon physical examination, the patient was alert and his hemodynamic state was normal. Swelling and crepitus were observed in the anterior aspect of the neck, extending to the anterior chest, head, left eye, and both upper arms. No signs of trauma or bleeding were detected in the mouth or oropharynx. The patient had clear lung sounds and normal heart sounds without any murmurs.

Initial radiographs revealed subcutaneous emphysema in the bilateral hemithorax without evidence of rib fracture. Cervical spine radiographs showed s

ubcutaneous emphysema in the bilateral cervical regions with an open air column. Further examination with flexible fiber optic laryngoscopy did not reveal any laryngeal injury or edema. Antibiotic therapy was initiated on the first day to prevent mediastinitis, with intravenous administration of Ceftriaxone 800 mg every 24 hours. However, there was no improvement in the subcutaneous emphysema by the third day. In an effort to rapidly decompress the evolving subcutaneous emphysema, 26-gauge IV catheters were placed into the tissue. The first needle was inserted into the deep plane of the chest wall at the area with the greatest air accumulation, resulting in immediate audible release of air. Massage was performed on the subcutaneous emphysema towards the needle

Figure 1. Picture of patient before needle decompression

On the sixth day after needle decompression, the subcutaneous emphysema in the anterior chest, neck, and left eye showed a decrease. The patient had no breathing difficulties or chest pain. After 14 days, there was minimal crepitation on the neck, and control radiographs showed complete resolution of the cervical emphysema. The patient was discharged with a prescription of Cefixime 2 x 80 mg for seven days. At the one-week follow-up, the patient reported no neck pain or odynophagia, and the subcutaneous emphysema had resolved..

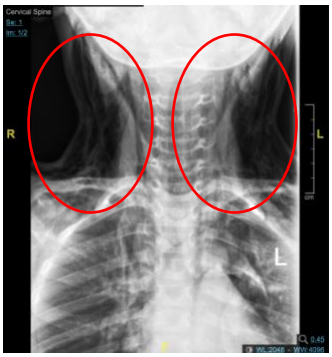

Figure 2. Neck Emphysema on Neck Radiograph

Figure 3. Day 6 after needle decompression

Case 2. Boy, 5-years old, came to Dr. Hasan Sadikin General Hospital outpatient clinic with complaint hoarseness since 3 years ago. Patient diagnosed with suspect papilloma of the larynx. Patient was planned to papilloma mass extraction by general anesthesia and tracheotomy pre operation by local anesthesia. Intraoperative, the patient had complications so that the patient neck was swelling. The complaint of swelling extends to the chest and back.

From the physical examination, the patient was fully alert and hemodynamic states was normal. From the otorhinolaryngology, head and neck examination the anterior aspect of the neck was swelling and crepitus, extending along the anterior chest and back. On auscultation, there was decreased vesicular breathing sound on the right side of the lung. The heart rhythm was regular, heart sounds were normal and there was no murmur. The chest radiograph post operative showed subcutaneous emphysema and right pneumothorax.

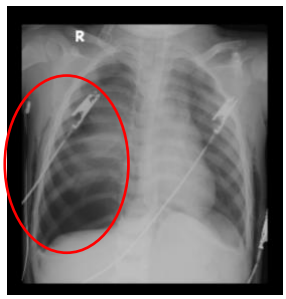

Figure 4. There was right pneumothorax and subcutaneous emphysema

For the management, antibiotic therapy was administered to prevent mediastinitis. Ceftriaxone 1 g was given intravenously every 24 hours. We decide to place 26 g IV catheters into the tissue. The first needle was placed at the area of the greatest air accumulation in the anterior chest wall. Management from thoracic surgery was the installation of the chest tube.

Figure 5. Day 0 after needle decompression and installation of the chest tube

On the third day after needle decompression and installation of the chest tube, there was subcutaneous emphysema on anterior chest, neck and back. The subcutaneous emphysema was decreased. From the thoracic surgery, the chest tube was released. Massage was carried out toward the needle decompression.

Figure 6. Day 3 after needle decompression

On the 12 days, total resolution of the cervical emphysema in the control radiographs. He was discharged home later that day with administration Cefixime 2 x 100 mg for seven days. At follow up 1 weeks later, the patient had no complaints of neck pain or odynophagia and subcutaneous emphysema.

Discussion

While subcutaneous emphysema is typically considered a non-life-threatening condition, its impact on patients and their families should not be underestimated.[1] The infiltration of air into the subcutaneous space of the chest wall sets off a cascade of effects, as the air gradually disseminates throughout the surrounding soft tissues, encompassing the face, neck, upper chest, and shoulders. This widespread distribution of air gives rise to the distinct swelling and deformities that are characteristic of subcutaneous emphysema. As a result, patients often experience considerable distress, and their families may also be greatly concerned about their well-being. While the cosmetic impact is more prominent, physiological problems such as tension pneumomediastinum, pneumothorax, or pneumopericardium rarely occur. It is important to note that the incidence of subcutaneous emphysema ranges from 0.43% to 2.34%, highlighting its relatively low occurrence in the general population. However, the impact of subcutaneous emphysema on individuals can still be significant, underscoring the need for appropriate diagnosis and management.[2,3]

Subcutaneous emphysema can arise from various causes, including surgical procedures, trauma, infections, or spontaneous factors. In the cases we are discussing, we present two instances of pediatric subcutaneous emphysema. In the first case, cervical emphysema developed as a result of a blunt neck injury in a young patient. The second case involves extensive emphysema that occurred as a complication during a tracheotomy procedure. These cases highlight the diverse etiologies and the importance of considering different factors that can lead to subcutaneous emphysema in pediatric patients. By understanding the specific circumstances surrounding each case, healthcare professionals can tailor their approach to effectively manage the condition and mitigate potential complications. [2,3]

Timely diagnosis and management are crucial in addressing subcutaneous emphysema and preventing further complications. In the cases we presented, various interventions were employed to effectively manage the condition. Needle decompression and antibiotic therapy were utilized to relieve the subcutaneous emphysema and prevent deep neck space or mediastinum infections. Needle decompression involves placing 26 g intravenous catheters into the affected tissues to release trapped air, while empirical broad-spectrum antibiotics were administered to mitigate the risk of infections. These interventions aim to reduce mortality rates associated with subcutaneous emphysema by promptly addressing the condition and preventing its potential complications.[10]

In conclusion, subcutaneous emphysema is a condition characterized by the presence of air within the soft tissues beneath the skin. Although it is generally not life-threatening, subcutaneous emphysema can cause significant discomfort and cosmetic deformities. The cases discussed above highlight the successful implementation of needle decompression and antibiotic therapy in relieving subcutaneous emphysema and preventing further complications. By considering the specific etiologies and employing appropriate interventions, healthcare professionals can effectively manage subcutaneous emphysema in pediatric patients, ensuring optimal outcomes and minimizing the impact on their overall well-being. Continued research and understanding of subcutaneous emphysema are crucial to further enhance diagnostic techniques and management strategies for this condition[11]

Harrison et al. documented two intriguing cases of surgical emphysema in pediatric patients, shedding light on the potential complications that can arise f

rom seemingly minor injuries. The first case involved a significant tear in the trachea, leading to extensive surgical emphysema. This patient faced challenges with compromised airway function and bilateral pneumothorax, necessitating critical interventions like intubation, bilateral chest drains, and surgical tracheostomy. The severity of the surgical emphysema posed limitations on certain medical procedures, including the use of ultrasound. Conversely, the second case demonstrated surgical emphysema in the neck without airway compromise, which was managed through a conservative approach. These cases serve as powerful reminders of the importance of tailoring treatment strategies to the individual patient's condition and highlighting the potential complexities associated with surgical emphysema.[8,9]

According to the findings by Harrison et al., surgical emphysema is a relatively common occurrence following laryngeal trauma, affecting a significant proportion of cases, ranging from 35% to 85%. The presentation of surgical emphysema can exhibit variations, and there is a possibility of rapid deterioration, underscoring the critical need for close monitoring and a high level of suspicion in successfully managing these cases among pediatric patients. Early recognition and appropriate management of surgical emphysema in this population are paramount.[2,3,4]

In a notable study conducted by Ardekian et al., an analysis of tracheostomy in maxillofacial surgery revealed that 36% of patients had experienced trauma. Among these cases, subcutaneous emphysema was observed in 13% of patients, while bleeding occurred in 16.2% of cases. The study also highlighted an overall complication rate of 2.7% for tracheostomy indications and perioperative complications within the oral and maxillofacial surgery service. It is crucial to recognize that the management approach for subcutaneous emphysema can significantly vary due to the diverse nature of cases, necessitating individualized treatment strategies based on the specific circumstances encountered.

Subcutaneous emphysema manifests as painless swelling of tissues, typically observed over the chest wall, neck, head, and around wound sites, although it can occur in any part of the body. A distinctive clinical sign of subcutaneous emphysema is the presence of a crackling sensation to the touch, known as crepitation. Patients may also experience accompanying symptoms such as chest pain, sore throat, difficulty swallowing, neck discomfort, breathlessness, and wheezing. Severe cases can even involve extensive swelling of the entire face and neck, occasionally accompanied by cardiopulmonary symptoms. In the cases we are discussing, the patients presented with painless swelling in the neck, and upon physical examination, crepitus was detected, consistent with the diagnosis of subcutaneous emphysema.[2,12]

Although the majority of cases of subcutaneous emphysema are nonfatal and self-limiting, there are situations where the rapid and extensive expansion of gas can give rise to life-threatening complications. Massive subcutaneous emphysema carries the risk of causing compartment syndrome, hindering the expansion of the thoracic wall, compressing the trachea, and leading to tissue necrosis. The use of nitrous oxide and positive pressure ventilation can exacerbate the expansion of gas, worsening the prognosis and increasing rates of morbidity and mortality. To address severe cases, various techniques have been described in the literature, including open blowhole incisions, negative pressure wound therapy, drains, or cervical mediastinotomy, all aimed at relieving the pressure and reducing the associated risks.[2,12,13]

In cases where subcutaneous emphysema is considered mild and does not cause significant discomfort to the patient, a common approach is close observation of the condition. Typically, subcutaneous emphysema resolves within a period of 10 days when the underlying cause is effectively managed. However, for more extensive cases, there have been reports suggesting the use of bilateral infraclavicular incisions as a means to prevent further expansion of the subcutaneous tissue. One case report detailed the successful treatment of a patient with extensive subcutaneous emphysema following thoracostomy through the placement of a subcutaneous drain positioned superficially to the pectoral fascia, utilizing low suction.[1,13]

In situations where severe subcutaneous emphysema is observed, catheters can be inserted into the subcutaneous tissue to facilitate the release of trapped air. This technique often involves making small incisions, commonly referred to as "blow holes," in the skin to allow for the escape of gas. When subcutaneous emphysema occurs as a result of pneumothorax, a frequently employed approach is the insertion of a chest tube, which aids in controlling and eliminating the source of air entering the subcutaneous space. However, in cases where the volume of subcutaneous air continues to increase, the efficacy of the chest tube in removing air from the pleural space may diminish. In such instances, it may be necessary to replace the chest tube with a larger one to ensure proper air removal. Additionally, the application of suction to the tube can expedite the removal of air. In cases of spontaneous subcutaneous emphysema, where the underlying condition is not severe, the primary treatment approach often involves bed rest, pain management, and the possible administration of supplemental oxygen. The provision of oxygen assists the body in absorbing the subcutaneous air more rapidly. Reassurance and close observation are also important components of treatment for mild forms of subcutaneous emphysema. It is important to note that when the underlying cause is effectively addressed, the resolution of subcutaneous emphysema is

typically expected to occur within a timeframe of fewer than 10 days.[2,5,6]

Robinson et al. presented a case report discussing the use of needle decompression as a technique to alleviate pressure in subcutaneous emphysema. They argued that their technique offers several advantages over other methods due to its minimally invasive nature, simplicity, and effectiveness. Unlike procedures involving large open infraclavicular incisions, which have been associated with issues such as bleeding, insufficient depth, and poor cosmesis, needle decompression requires no special drains or equipment. In their experience, this technique has proven to be an excellent temporary measure, assisting in the complete resolution of the underlying cause of subcutaneous emphysema or serving as a bridge to more definitive procedures, such as video-assisted thoracoscopic wedge resection of the affected lung segment. The placement of angiocatheter needles for decompression is generally well-tolerated, as the distention of the skin renders it relatively insensate. The accessibility, low cost, simplicity, quick application, and high efficacy of percutaneous angiocatheters make them particularly advantageous in the treatment of severe subcutaneous emphysema. It is worth noting that no instances of infection were reported, although the angiocatheters often became obstructed with clot over time, as observed upon their removal.[13]

Reviewing the existing literature reveals that only a few case reports highlight techniques to alleviate pressure in subcutaneous emphysema, such as blowhole incisions, negative pressure wound therapy, drains, or cervical mediastinotomy. While all of these techniques effectively decompress and relieve subfascial pressure, needle decompression stands out due to its minimally invasive, simple, and effective nature. It does not require specialized drains or equipment and avoids the potential drawbacks associated with larger open infraclavicular incisions. In practice, needle decompression has proven to be an excellent temporary measure, facilitating the complete resolution of underlying causes or serving as a bridge to more definitive procedures. The ease of access, low cost, simplicity, and quick application further contribute to the high efficacy of percutaneous angiocatheters in treating severe subcutaneous emphysema. It is important to mention that infection instances were not reported, although angiocatheters often became obstructed with clot over time, as observed upon their removal.[6,7,8]

Shires et al. described a case involving an 8-year-old female who tripped over a pet and struck the anterior portion of her neck on the edge of a coffee table. The patient presented with swelling of the neck and exhibited crepitus throughout the neck, scalp, chest, bilateral upper extremities to the fingertips, and bilateral lower extremities down the shins. Panendoscopy revealed a 2-3 cm vertical laceration on the posterior tracheal wall approximately 3 cm below the level of the true vocal cords. The tracheal defect was closed using 4-0 PDS sutures in a two-layered closure. The patient received empirical antibiotic treatment and had her chest tubes removed without any complications on hospital days 6 and 7. During a follow-up visit one week after discharge, the patient reported no complaints, indicating a successful outcome of the treatment[13]

In a case report by Buchbender et al., the administration of intravenous Cefuroxim at a dosage of 1.5 g, three times a day, proved to be effective in resolving subcutaneous emphysema after a period of 14 days. Similarly, Tenore et al. reported a successful resolution of subcutaneous emphysema after 30 days by administering the antibiotic ceftriaxone to their patient. The administration of antibiotics intravenously helps reduce the risk of additional infections in cases of subcutaneous emphysema.[6,13]

In our patients, the management of subcutaneous emphysema involved needle decompression for all individuals and chest tube insertion in the second case, specifically due to the presence of pneumothorax. As described in a report by Robinson et al., their patients with subcutaneous emphysema underwent needle decompression in the right upper lateral chest wall and left upper chest wall. This procedure effectively alleviated the progressive subcutaneous dissection, resulting in the resolution of subcutaneous emphysema in all patients without the need for additional invasive therapies.[6,13]

In certain cases, conservative management that involves fluid administration and antibiotic treatment may be deemed appropriate. However, it is crucial to closely observe patients to monitor for signs of sepsis or respiratory compromise. In our study, all of the patients were prescribed a course of antibiotics, and none of them experienced tracheitis, laryngitis, chondritis, or wound infection. These findings align with those of Tenore et al., where their patient's subcutaneous emphysema resolved after 30 days of treatment with ceftriaxone. Similarly, Dolci et al. reported a successful resolution of swelling by administering a combination of amoxicillin and clavulanic acid at a daily dosage of 3g for 7 days, resulting in complete resolution after 2 weeks. The use of antibiotics is crucial in minimizing the potential introduction of bacteria into deeper subcutaneous spaces. Amoxicillin and clavulanic acid are commonly preferred medications for managing subcutaneous emphysema, and most episodes resolve within 7-10 days without any adverse consequences. Additionally, alternative antibiotics such as clindamycin, ceftriaxone, ampicillin, ciprofloxacin, and cefuroxime can also be considered. Empirical antibiotic coverage is recommended to reduce the risk of secondary infections, especially when air enters the body thr

ough a contaminated route, as the introduction of air often carries microorganisms from the surrounding flora[11,13]

Subcutaneous emphysema can manifest as either a self-limited condition or a medical/surgical emergency that requires prompt intervention. In extensive cases of subcutaneous emphysema, needle decompression has proven to be effective in relieving pressure, while the use of antibiotics helps reduce mortality rates. Both procedures contribute to speeding up the recovery time from extensive subcutaneous emphysema, facilitating a more favorable outcome for the patients

REFERENCES

1. Gök H. A rare case report: Cervical subcutaneous and mediastinal emphysema due to mastoid fracture. Ulus Travma ve Acil Cerrahi Derg. 2020;26(2):328-30.
2. Aghajanzadeh M, et al. Classification and Management of Subcutaneous Emphysema: a 10-Year Experience. Indian J Surg. 2015;77(December):673-7.
3. Kelsey Kukuruza. Subcutaneous Emphysema. 2020; Available from: https://www.ncbi.nlm.nih.gov/books/NBK542192/#article-29619.r3
4. Oosthuizen JC. Paediatric Blunt Laryngeal Trauma: A Review. Int J Otolaryngol. 2011;2011:1-3.
5. Harrison R. Surgical Emphysema in a Pediatric Tertiary Referral Center. Pediatr Emerg Care. 2020;36(1):E21-4.
6. Mohamad I. Massive Subcutaneous Emphysema After A Blunt Neck Injury. 2017;2(1):16-20.
7. Sun TY. A Rare Presentation of Asymptomatic Spontaneous Pneumomediastinum. Cureus. 2021;13(Mcv):3-7.
8. Sogut O. Pneumomediastinum and subcutaneous emphysema due to blunt neck injury: A case report and review of the literature. 2011;61(7):702-4.
9. Jiang Y. Delayed Post-Operative Subcutaneous Emphysema. Cureus. 2021;13(2):1-6.
10. Robinson B. Rapid resolution of severe subcutaneous emphysema with simple percutaneous angiocatheter decompression. J Surg Case Reports. 2018;2018(7):1-3.
11. Ardekian L. Subcutaneous emphysema following emergent surgical conventional tracheostomy. Craniomaxillofacial Trauma Reconstr. 2014;7(4):290-3.
12. Da Costa Medeiros BJ. Subcutaneous emphysema, a different way to diagnose. Rev Assoc Med Bras. 2018;64(2):159-63.
13. Shires CB. Pediatric laryngeal trauma: A case series at a tertiary children's hospital. Int J Pediatr Otorhinolaryngol [Internet]. 2011;75(3):401-8. Available from: http://dx.doi.org/10.1016/j.ijporl.2010.12.016