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CASE SERIES

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Can sub-cutaneous drain safely counter debilitating surgical emphysema? A retrospective study in quest for an answer

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Abstract

Literature evidence on sub-cutaneous drain insertion in severe surgical emphysema (SE) is lacking. We retrospectively reviewed the clinical notes of 5 patients who underwent insertion of sub-cutaneous drains to manage SE of various aetiologies between September 2022 to August 2023 in a single district general hospital in the UK. Case history, outcome following sub-cutaneous drain insertion, and side effects due to the procedure were collected. Clinical decompression were noticed within an hour of drain insertion in all patients. Radiological resolution ranged between 2 and 10 days with a median 3 days and mean of 4.8 days. Patients with uni-lateral sub-cutaneous drain required more time for radiological improvement than patients on bi-lateral drains (median 6.5 vs. 2, mean 6.5 vs. 3.6). Maximum duration for resolution was 10 days for patients receiving uni-lateral sub-cutaneous drain versus 7 days in patients having bi-lateral drains. Only one patient had no prior lung disease making it difficult to comment if having healthy lungs affects outcomes. Sub-cutaneous drain insertion is a safe procedure which can accelerate recovery in severe SE.

KEYWORDS

pneumo-mediastinum, pneumothorax, sub-cutaneous drain, surgical emphysema

INTRODUCTION

There is no published case series or study of any form on the outcome of sub-cutaneous drain (SC drain) insertion in debilitating surgical emphysema (SE). There are sparse case reports of such. Literature studies do give us information about various interventions that can be attempted in severe SE, but none have undergone any formal study or head-to-head comparison. In this article, we present the first ever retrospective analysis of a case series consisting of five patients suffering from pneumo-mediastinum and severe surgical emphysema successfully treated with subcutaneous drainage. We used a grading system mentioned by Aghajanzadeh and co. in 2015[1] to clinically categorize surgical emphysema.

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Methods

No formal ethical approval was required. A retrospective review was conducted by going through the clinical notes of five patients who underwent insertion of a sub-cutaneous drain to manage surgical emphysema due to different aetiologies in a single district general hospital in the UK between September 2022 and August 2023. Written consent was obtained from all five patients. Case history, outcome following subcutaneous drain insertion, and any side effects experienced due to the procedure were collected. Patient demographics are summarized in Table 1.

TABLE 1 Patient demographics.

Case	Age	Gender	Comorbidity
1.	31	Male	Autism
2.	54	Female	Previous pneumothorax (2016)
			Raised BMI
			COPD (emphysema)
			COVID-19 (2021)
3.	85	Male	SCC penis (2018)
			Hypertension
			Idiopathic pulmonary fibrosis
4.	75	Female	Asthma
			Idiopathic pulmonary fibrosis with 0.5 L home oxygen
5.	76	Male	COPD
			Hypothyroidism

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; SCC, squamous cell carcinoma.

Insertion of the drains for our patients was conducted as followed: we created a 2 cm horizontal skin incision midway between the clavicle and nipple in the mid-clavicular plane, followed by forming a vertical subcutaneous tract superficial to the pectoral fascia using a blunt dissection technique and placing the chest drain within the tract (approximately 8 cm inside), which is to be connected to the underwater seal bottle. We placed the drains under suction (−0.5 kpA to −2.0 kpA) for all the patients.

Case 1

A gentleman in his 30s presented to the emergency department due to the sudden development of tightness and swelling around his neck and chest. A chest x-ray and subsequent chest computed tomography (CT) showed pneumo-mediastinum with extensive surgical emphysema (SE) and bilateral consolidation. On examination, he had grade 4 surgical emphysema with bilateral coarse crackles. Later, as he developed upper airway compression symptoms, a 12-french drain was inserted subcutaneously on the right side and kept under suction (−0.5 to −2 kpa). Clinical improvement was noted within an hour and radiological resolution within 4 days (Tables 2 and 3).

Case 2

A lady in her 50s with a background history of COPD presented to the emergency department with a 1-day history of breathlessness and right-sided chest pain. Imaging showed a large right-sided pneumothorax. An 18-french intercostal chest drain (ICD) was inserted resulting in immediate clinical improvement. A few hours later, she became more ill. She had stiffness and swelling around her neck, which progressed to her chest. Clinically, she had grade 4 SE. The ICD was patent, and a repeat X-ray of her chest showed correct positioning of the ICD, with additional new findings of SE present on both sides of her chest and neck. Therefore, her ICD was put on suction (initially −0.5 kpA, increased up to −2.0 kpA). She deteriorated further in the next few hours despite this action. She developed facial and eyelid swelling, along with bilaterally swollen arms. She now had grade-5 surgical emphysema. She was immediately transferred to a critical care unit for urgent intubation. Following intubation, a 12-french drain was inserted subcutaneously on her left side. The drain was kept at −0.5 kpa to −2.0 kpa suction. Within an hour, her facial and neck swelling started to settle down. Her subcutaneous drain remained for 3 days, after which it was removed with a satisfactory outcome. She was later transferred to the cardiothoracic team for a video-assisted thoracoscopic (VATS) procedure after extubation (Tables 2 and 3).

Case 3

A gentleman in his 80s with advanced interstitial lung disease presented to the emergency department with a 1-day history of breathlessness and cough with greenish sputum. He was treated for an infective exacerbation of pulmonary fibrosis with steroids, antibiotics, and bronchodilators. On day 3 of his hospital stay, he developed bilateral chest pain associated with difficulty in swallowing liquid and solid food. On examination, he had neck and chest swelling with subcutaneous crepitation and a positive Hamman's sign. A chest x-ray and subsequent CT chest showed pneumo-mediastinum and SE. Clinically a grade-4 SE. He had bilateral 12-french drains inserted subcutaneously and kept under suction (−0.5 kPa to −2.0 kPa). He showed significant clinical improvement within an hour of the insertion of the drains. His subcutaneous drains were removed after 2 days with satisfactory radiological improvement (Tables 2 and 3).

Case 4

A lady in her 70s with advanced interstitial lung disease presented to the emergency department with a week-long history of worsening breathlessness. She was treated for infective exacerbation of pulmonary fibrosis with steroids, a bronchodilator, and antibiotics. She developed swelling around her neck and chest a few days after her hospital admission. An x-ray of her chest revealed pneumo-mediastinum with SE. Clinically, a grade 4 SE. 12-french drains were inserted subcutaneously on both sides, which resulted in the rapid resolution of her clinical symptoms within an hour. Suction was applied alternatively to each drain (−0.5 to −2.0 kpa). It took 7 days for radiological improvement after which both the drains were removed (Tables 2 and 3).

TABLE 2 Technique of sub-cutaneous drain insertion and its outcome analysis.

CASE and grade of surgical emphysema (SE)	Drain type, size	Insertion technique	Uni/Bi-lateral	Suction applied	Associated pneumo-thorax	Pre-existing ICD	Associated pre-existing lung disease	Clinical decompression achievement	Radiological improvement and drain removal
Case-1 (Grade-4 SE)	12 french seldinger rocket chest drain	Mid-clavicular plane midway between clavicle and nipple (8 cm tract)	Uni-lateral	Yes	No	No	No	Within 1 h	2 days
Case-2 (Grade-5 SE)	12 french seldinger rocket chest drain	Mid-clavicular plane midway between clavicle and nipple (8 cm tract)	Uni-lateral	Yes	Yes	Yes	Yes (COPD)	Within 1 h	3 days
Case-3 (Grade-4 SE)	12 french seldinger rocket chest drain	Mid-clavicular plane midway between clavicle and nipple (8 cm tract)	Bi-lateral	Yes	No	No	Yes (ILD)	Within 1 h	2 days
Case-4 (Grade-4 SE)	12 french seldinger rocket chest drain	Mid-clavicular plane midway between clavicle and nipple (8 cm tract)	Bi-lateral	Yes	No	No	Yes (ILD)	Within 1 h	7 days
Case-5 (Grade-4 SE)	12 french seldinger rocket chest drain	Mid-clavicular plane midway between clavicle and nipple (8 cm tract)	Bi-lateral	Yes	Yes	Yes	Yes (COPD)	Within 1 h	10 days

Abbreviations: COPD, chronic obstructive pulmonary disease; ICD, intercostal drain; ILD, Interstitial lung disease.

TABLE 3 Analysis of clinical and radiological outcome with side effects.

1. Clinical resolution	All patients showed clinical improvement (decompression) within an hour				
2. Radiological improvement and drain removal	In general (Total 5 patients)	Patient with pre-existing lung disease	Patient with no pre-existing lung disease	Uni-lateral drain	Bi-lateral drain
	Median: 3	Median: 5	Only 1 patient: 2 days for resolution and drain removal	Median: 6.5	Median: 2
	Mean: 4.8	Mean: 5.5		Mean: 6.5	Mean: 3.6
	Minimal: 2	2		Minimal: 3	Minimal: 2
	Maximum: 10	10		Maximum: 10	Maximum: 7
3. Any significant bleeding?	No				
4. Any clot formation?	No				
5. Cosmetic problem?	Minor scar on the drain insertion site. Only 2 of the 5 patients had 6-week interval follow up which showed resolution of the scar.				

Case 5

A gentleman in his 70s with COPD presented to the emergency department with a week-long history of shortness of breath and not responding to his usual inhalers associated with a 1-day history of chest pain. Chest x-ray showed a large right-sided pneumothorax. A 12-french ICD was inserted. Two days later, he became more breathless and developed grade 4 SE. Repeat x-ray showed worsening of the pneumothorax and severe SE. His initial ICD was patent and then placed on suction (−0.5 to −2.0 kpa). Despite keeping the ICD under suction, his surgical emphysema progressed. A 28-french surgical chest drain was inserted, and the old one was removed. SE still worsen, and he developed upper airway compression symptoms. He had an initial skin incision for SE, which bled heavily. The incision site became blocked with clots. Therefore, bilateral 12-french drains were inserted subcutaneously. It resulted in rapid decompression within an hour. Both the ICD and the SC drains were removed after 10 days of SC drain insertion with satisfactory imaging outcome (Tables 2 and 3).

DISCUSSION

Pneumo-mediastinum, as the name suggests, means the presence of air in the mediastinum. It was first described by Laennec way back in 1827.[2] It can be spontaneous or secondary to trauma or iatrogenic due to certain procedures (such as endoscopic procedures, intubation, pleural procedures, central line insertion, etc.).[3] It can occur as a consequence of perforation of the oesophagus or secondary to underlying lung pathology.[3] Clinical features range from an asymptomatic, self-limiting radiological finding to chest pain, shortness of breath, and surgical emphysema. Macklin and Macklin provided us with a possible explanation of how air can travel through the mediastinum after experimenting on cats back in 1944.[4] They suggest alveolar rupture due to any cause can lead to leakage of air into the interstitial spaces, travelling through the perivascular and peribronchial sheaths to the hilum of the lung to eventually end up in the low-pressure mediastinum. The most common site is at the root of the neck, as the visceral layer of the deep cervical fascia is continuous with the mediastinum. Later, free air can spread to the face, limbs, abdomen, and perineum. As explained, air in the mediastinum can eventually lead to surgical emphysema. Clinical grading of SE was provided by Aghajanzadeh and co. in 2015.[1] We used the same grading system to clinically categorize the SE of our five patients. SE also remains a common complication following procedures such as thoracostomy, thoracoscopy, thoracotomy, pleural or lung biopsies, and so on. Habitually, it follows a benign course not requiring any treatment. It is usually resolved within 10 days, more rapidly if the cause is adequately treated.[5,6] Rarely can it result in upper airway compression due to significant air pressure on the trachea or oesophagus. Such a severe and debilitating form of SE needs urgent attention. A variety of approaches exist in literature studies, although there seem to be no controlled trials or guidelines available on their management. Commonly used methods to treat clinically significant surgical emphysema found during our literature study are insertion of a chest drain in the presence of an ongoing pneumothorax; placing an existing intercostal drain on suction; insertion of a larger ICD; skin incisions; drainage via 'blow holes'; drainage via sub-cutaneous angio-catheters; drainage via insertion of a sub-cutaneous drain (SC drain); and lastly, surgical repair.[7] The most comprehensive review found was by Johnson et al.[8] who described the outcomes of such interventions in various case reports. They concluded that no single method can be determined as the best in the absence of a larger randomized control trial.

We attempted to discover the answer to the question: does sub-cutaneous (SC) drain insertion aid in decompressing severe sub-cutaneous emphysema, and if so, are there any major side effects that can restrict its use in our daily clinical practice? From our experience, the answer is rather

TABLE 4 Analysis of sub-cutaneous drain insertion techniques in existing case reports.

Literature	Site of insertion	Tube size	Application of suction	Clinical effectiveness	Associated pneumothorax	Associated ICD
Sherif et al.[10]	Mid-clavicular line (8 cm tract)	Medium size Jackson Pratt tube	Yes (not mentioned pressure)	Resolved within 3 h	No	No
Kelly et al.[9]	Mid-clavicular line (Left 5th intercostal space to right neck)	28 french	Yes (pressure not mentioned)	Resolved within 1 h	Yes	Yes
Tran et al.[12]	Anterior axillary line (8 cm tract)	26 french	Yes (−5 cm H_2O)	Resolved within 1 h	Yes	Yes
O'Reily et al.[11]	Mid-clavicular line (6 cm tract)	12 french	Yes (−5 cm H_2O)	Resolved within 1 h	Yes	Yes

optimistic, as we found SC draining is a relatively simple and safe procedure that can negotiate severe SE and result in rapid resolution.

There is no proper guidance on its insertion technique or selection of drain tube size. The references we found for using SC drain in the literature were Kelly et al in 1995, Sherif et al. in 1997, O'Reilly, Chen & Wiseman in 2013 and Tran, Mizumoto & Mehanna in 2018.[9–12] We summarized the insertion site, choice of tube size, application of suction, and clinical effectiveness reported in these studies in Table 4.

In the above-mentioned data, clinical decompression and improvement were achieved in all the cases within 1 h, apart from the one described by Sherif et al., which required 3 h. In all these reported cases, the drain was kept under suction. A major difference was that Sherif et al. used a Jackson Pratt tube, whereas the rest used chest drain tubes of various sizes. However, based on the data we reviewed, the size variation of the drain tube does not appear to impact the time of clinical improvement. We used 12-french chest drain in all our 5 patients and found it effective enough to achieve clinical improvement or decompression within an hour.

There is no proper guidance on the timing of its use during the illness, either. It relies on clinical decision.

Insertion of the drains for our patients was conducted as described in the methods section. Three out of the 5 patients had bilateral SC drains, whereas the other 2 patients had unilateral ones. There was no apparent reason to make a unilateral drain other than a physician's choice. It was noted that patients with unilateral SC drains required more time for radiological resolution than those with bilateral SC drains (median: 6.5 vs. 2 and mean: 6.5 vs. 3.6). The maximum duration for radiological resolution with a unilateral SC drain was 10 days, compared to 7 days with a bilateral. The probable reason for the difference in duration of recovery, we believe, is not the number of drains but rather the original pathology. Both patients with uni-lateral drains had end-stage COPD and had ongoing, prolonged air leaks despite remaining on ICD.

The most common side effect we noticed among all the patients was minor bleeding during the procedure. It ceased within a few minutes. There is a risk of clot formation as per the literature, but none of our patients experienced clots, probably because the drains were left into suction, which prevented any clot formation within the drain tubes. This is a significant advantage over other methods found to be used in the literature for severe SE, such as skin incision, blow-hole, and angio-catheter, as all of those methods reported major issues with clot formation.

In conclusion, the procedure of sub-cutaneous drain insertion is simple and is associated with negligible side effects such as bleeding, possible clot formation, and cosmetic (anterior chest scar). It can aid in rapid recovery. It can prevent patients from requiring intubation, thus preventing prolonged hospital stays and intubation-related complications. Our study shows acceleration of clinical recovery of grade 4 or above surgical emphysema with negligible side effects. Although our study found subcutaneous drain insertion safe and effective, it has its own limitations. We had a small sample size performed in a single centre. However, since there are no larger studies currently published on the application of sub-cutaneous drain in surgical emphysema, we believe our experience will guide physicians to make more confident decisions, particularly in patients who are not fit for further escalation apart from a ward-based ceiling of care. We recommend a larger study be conducted for more conclusive evidence.

AUTHOR CONTRIBUTIONS

Dr. Saquib Navid Siddiqui: Design, analysis, writing whole manuscript. Dr. Umair Falak: Contributed with drafting and final approval of the manuscript. Dr. Ned Frost: Contributed with data analysis. Dr. Waseem Athar: Contributed with drafting the manuscript. Dr. Muhammad Haroon Mujtaba Memon: Contributed with data analysis. Dr. Asma Zeeshan Qazi: Contributed with data analysis.

CONFLICT OF INTEREST STATEMENT

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The authors declare that appropriate written informed consent was obtained for the publication of this manuscript from all the patients.

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