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Case Report

ARCHIVES OF CLINICAL AND MEDICAL CASE REPORTS

ISSN: 2575-9655

Extensive Subcutaneous Emphysema and Pneumomediastinum Following Intralesional Cryotherapy: A Case Report and Literature Review of a Rare and Unusual Complication

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Abstract

The Cryotherapy is a widely used treatment for various dermatological conditions, including warts, actinic keratosis, basal cell carcinoma, and keloid scars. While generally safe, potential complications of cryotherapy include blistering, hypopigmentation, hyperpigmentation, infection, scarring, subcutaneous emphysema, and pneumomediastinum. This report describes a rare case of extensive subcutaneous emphysema and pneumomediastinum following intralesional cryotherapy for a keloid. A 36-year-old female with a biopsy-proven keloid in the left scapular region, persisting for 30 years after surgery, underwent intralesional cryotherapy following eight unsuccessful sessions of intralesional steroid injections and superficial cryotherapy. One hour after the procedure, she presented with left shoulder, arm, and neck pain, swelling, dysphagia, and mild shortness of breath. Physical examination revealed subcutaneous crepitus, and thoracic CT confirmed subcutaneous emphysema and pneumomediastinum. The patient was hospitalized, monitored closely, and treated with intravenous ceftriaxone and levofloxacin to prevent mediastinitis. Oxygen therapy facilitated air resorption, and her oxygen saturation remained stable throughout. Follow-up imaging confirmed resolution of the pneumomediastinum and significant improvement in subcutaneous emphysema. This case underscores the importance of recognizing the rare but serious complications of intralesional cryotherapy. Early diagnosis, conservative management, and prophylactic antibiotics are essential to prevent severe outcomes, ensuring patient safety and optimal care.

Keywords: Intralesional Cryotherapy; Keloid; Complications; Subcutaneous emphysema; Pneumomediastinum

Introduction

Dermatology has evolved significantly in its ability to manage various skin lesions and conditions through a variety of interventional procedures [1]. These procedures range from minimally invasive techniques, such as cryotherapy, laser therapy, and chemical peels, to more invasive methods, including excisions, punch biopsies, and intralesional injections [2]. Among these, cryotherapy stands out as a simple, effective, and widely used technique, particularly for treating benign and premalignant skin lesions [3]. Cryotherapy involves the application of extreme cold to destroy abnormal or diseased tissue [4]. Liquid nitrogen, which has a boiling point of -196°C, is the most commonly used cryogen due to its effectiveness in achieving

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Citation: Hatice Gencer Başol, İsmail Kürşat Gürlek, Selma Aktaş, Mustafa Boz, Betül Tiryaki Baştuğ.Extensive Subcutaneous Emphysema and Pneumomediastinum Following Intralesional Cryotherapy: A Case Report and Literature Review of a Rare and Unusual Complication. Archives of Clinical and Medical Case Reports. 9 (2025): 05-10

Received: December 29, 2024
Accepted: January 06, 2025
Published: January 13, 2025

Başol HG, et al., Arch Clin Med Case Rep 2025
DOI:10.26502/acmcr.96550701

rapid tissue freezing [5]. The process causes intracellular ice formation, leading to cell membrane rupture and subsequent tissue necrosis. The frozen tissue eventually sloughs off, allowing for the regeneration of healthy skin. This technique is employed for a range of dermatological conditions. Common indications include benign lesions such as warts, seborrheic keratosis, and dermatofibroma; premalignant lesions like actinic keratosis; and superficial malignancies such as basal cell carcinoma [6]. Cryotherapy is also widely used in the treatment of hypertrophic scars and keloids, especially in cases where other treatments, such as corticosteroid injections, have proven ineffective [7]. Cryotherapy can be administered in various ways depending on the nature and location of the lesion. The most commonly used methods are spray cryotherapy, where liquid nitrogen is sprayed directly onto the lesion, and probe cryotherapy, which employs a cryoprobe to deliver controlled freezing to the target area [8]. Intralesional cryotherapy, a more specialized technique, involves injecting liquid nitrogen directly into the lesion, ensuring deeper and more precise treatment. This approach is particularly beneficial for thicker lesions like keloids, where superficial methods might be inadequate [9]. Despite its effectiveness, cryotherapy is not without risks. Common side effects include pain during and after the procedure, blister formation, hypopigmentation, hyperpigmentation, and scarring [10]. Rare complications, such as subcutaneous emphysema and pneumomediastinum, may occur, especially with intralesional cryotherapy, underscoring the need for careful patient selection and procedural expertise. This report highlights the case of a 36-year-old female who developed extensive subcutaneous emphysema and pneumomediastinum following intralesional cryotherapy for a refractory keloid. Through this case, we aim to underscore the potential risks associated with this widely used dermatological intervention and emphasize the importance of recognizing and managing rare but serious complications.

Case Presentation

A 36-year-old female presented with a long-standing keloid in the left scapular region. The lesion had developed 30 years earlier following a surgical procedure. Over the years, the patient had experienced persistent discomfort and cosmetic concerns related to the keloid (Figure 1). A biopsy confirmed the diagnosis, and she underwent eight sessions of intralesional steroid injections combined with superficial cryotherapy at four-week intervals, all of which failed to produce significant improvement. Due to the refractoriness of the lesion, intralesional cryotherapy was performed. Liquid nitrogen was injected directly into the keloid using a specialized cryotherapy device to achieve deeper and more targeted freezing. The procedure was uneventful, and the patient was discharged with standard post-procedure care instructions. One hour later, she returned to the emergency department with complaints of left shoulder, left arm, and neck pain accompanied by swelling. She also reported dysphagia and mild shortness of breath. On examination, the patient's vital signs were stable, and her oxygen saturation was normal. However, palpable subcutaneous crepitus was noted extending over the neck, left shoulder, and chest wall. A thoracic computed tomography (CT) scan revealed extensive subcutaneous emphysema in the neck and thoracic region and pneumomediastinum. No tracheal or esophageal perforation was identified (Figure 2). The patient was admitted to the hospital for close monitoring. Intravenous ceftriaxone and levofloxacin were initiated to prevent mediastinitis. She was placed on oxygen therapy to facilitate the resorption of air. Over the next four days, her symptoms progressively improved, and follow-up imaging showed a significant reduction in subcutaneous emphysema and pneumomediastinum (Figure 3). The patient was discharged in stable condition with no long-term sequelae. This case highlights the rare but potentially serious complications of intralesional cryotherapy and emphasizes the importance of early recognition, conservative management, and appropriate preventive measures (Table 1).

Discussion

Cryotherapy is a highly versatile and effective modality in dermatology, widely used to treat various benign, premalignant, and superficial malignant skin lesions [11]. Its mechanisms rely on the rapid freezing and thawing of tissue using cryogens such as liquid nitrogen, leading to cell destruction through ice formation and vascular stasis [12]. However, despite its widespread use and general safety, cryotherapy is not without risks. Complications range from mild, transient effects such as pain, erythema, and blister formation to more serious adverse events like infection, hypertrophic scarring, and, in rare cases, subcutaneous

Figure 1: Clinical appearance of a keloid lesion in the left scapular region of a 36-year-old female prior to intralesional cryotherapy. Note the hypertrophic, irregular, and discolored surface characteristic of a long-standing keloid.

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DOI:10.26502/acmcr.96550701

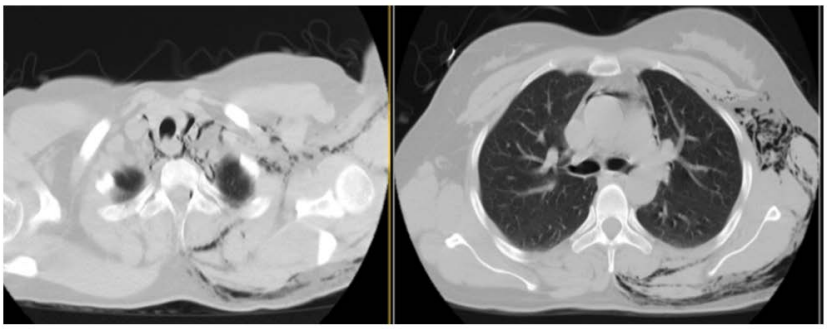

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Figure 2: Axial thoracic CT images highlighting the progression and distribution of subcutaneous emphysema and pneumomediastinum. (A): Axial CT of the upper chest on the day of presentation. Extensive subcutaneous emphysema is noted along the thoracic inlet and surrounding the mediastinal structures. Air is visible within the subcutaneous tissues extending from the neck into the thoracic region. (B): Axial CT at the mid-thoracic level showing air pockets distributed within the subcutaneous layers and mediastinum. Clear tracking of gas along the fascial planes is evident, with no compromise of major vascular or airway structures.

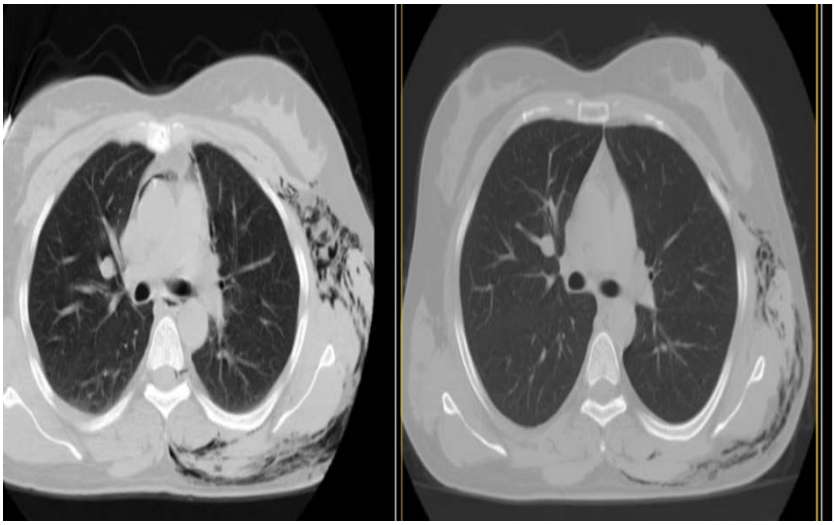

Figure 3: Axial thoracic CT images demonstrating the evolution of subcutaneous emphysema and pneumomediastinum.

Left Panel (Day 1): Extensive subcutaneous emphysema is visible along the thoracic wall and neck regions, with clear evidence of air tracking into the mediastinum. This represents the acute presentation one day following intralesional cryotherapy.

Right Panel (Day 4): Significant resolution of subcutaneous emphysema and pneumomediastinum is noted, following conservative management with oxygen therapy and prophylactic antibiotics. Air pockets in the subcutaneous tissue and mediastinum have diminished, consistent with clinical improvement.

emphysema and pneumomediastinum [13]. These rare complications merit particular attention, especially in procedures involving intralesional cryotherapy, where cryogen delivery is more invasive and targeted.

The development of subcutaneous emphysema and pneumomediastinum during cryotherapy procedures is multifactorial [14]. During intralesional cryotherapy, liquid nitrogen, delivered under pressure, undergoes rapid phase transition, creating gas pockets within tissues. If these gases disrupt natural barriers such as fascial planes, they can track through subcutaneous tissues and potentially reach the mediastinum. This phenomenon is particularly common when treating lesions near anatomical areas with connections to the thorax, such as the shoulder, neck, and chest wall. The pressure generated by excessive cryogen injection, combined with the low resistance of the soft tissue planes, facilitates gas migration. Additionally, the mechanical disruption caused by intralesional injections can further compromise tissue integrity, predisposing to gas tracking. Pneumomediastinum, though rare, is a critical complication because it can progress to mediastinitis, a potentially life-threatening condition requiring urgent medical intervention [15].

To mitigate the risk of these rare but severe complications, several precautionary strategies can be adopted. First, patient selection and procedural planning are crucial. Identifying high-risk anatomical areas and considering the patient's

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history of procedural tolerance are essential. Pre-procedural imaging, such as ultrasound, can provide valuable insights into the lesion's characteristics, including depth, vascularity, and proximity to vital structures. Collaboration with interventional radiologists and utilizing ultrasound-guided intralesional cryotherapy can enhance procedural precision, ensuring that cryogen is delivered only to the targeted lesion while minimizing inadvertent damage to surrounding tissues. Gradual freezing cycles and limiting cryogen volume can reduce tissue disruption and excessive gas formation. In addition, using appropriate needle sizes and depths for injection may decrease the likelihood of air tracking along soft tissue planes. For lesions located in high-risk areas, alternative or adjunctive treatment modalities, such as laser therapy or superficial cryotherapy, may be safer options. Adopting a conservative cryotherapy approach, tailored to the specific lesion and its anatomical location, can also reduce the risk of complications.

Close monitoring after the procedure is essential for early recognition of complications. Patients should be educated about the signs and symptoms of potential complications, including swelling, pain, dysphagia, and respiratory distress, and advised to seek immediate medical attention if these occur. Imaging studies, particularly computed tomography (CT), play a critical role in confirming diagnoses such as subcutaneous emphysema and pneumomediastinum [16]. Most cases of subcutaneous emphysema and pneumomediastinum can be managed conservatively. Treatment often includes oxygen therapy to accelerate gas absorption, prophylactic antibiotics to prevent secondary infections such as mediastinitis, and close observation for signs of clinical deterioration. The favorable outcomes in most reported cases highlight the importance of early diagnosis and prompt, appropriate management [17].

Literature Review and Case Insights

Literature Review

Cryotherapy is a well-established treatment modality for a variety of dermatological and oncological conditions. Its mechanism, based on the application of extreme cold to induce tissue necrosis, has made it a preferred choice for treating benign, premalignant, and malignant lesions. However, like any medical intervention, cryotherapy is not devoid of risks, with complications ranging from common and mild effects to rare but serious outcomes.

The most frequently observed complications include localized pain, blistering, hypopigmentation, hyperpigmentation, and transient swelling. These are typically self-limiting and manageable with supportive care. In rare cases, however, cryotherapy can lead to more severe outcomes, such as frostbite, nerve damage, or paradoxical adipose hyperplasia (PAH), where the treated area paradoxically increases in adipose tissue rather than reducing. Another complication that has garnered attention in the literature is chemotherapy-induced oral thermal hyperalgesia (OTH), especially when cryotherapy is used adjunctively during cancer treatments [18-21].

Among these, the rare development of subcutaneous emphysema and pneumomediastinum warrants special attention. Subcutaneous emphysema occurs when gas infiltrates the soft tissues, often as a result of excessive pressure or anatomical vulnerabilities. When this air tracks along fascial planes and breaches the thoracic inlet, it can lead to pneumomediastinum, a condition where air accumulates in the mediastinum. Pneumomediastinum is a potentially serious complication due to its proximity to critical thoracic structures such as the heart and major vessels. Its occurrence following cryotherapy is linked to procedures involving high-pressure cryogen injection, particularly in areas close to the thoracic inlet, such as the neck, chest, and shoulders. While the condition is rare, its clinical implications necessitate prompt recognition and management to avoid progression to life-threatening sequelae, such as mediastinitis.

Another review of the literature provides valuable insights into these rare complications of cryotherapy, such

Table1: The table provides some of documented complications associated with cryotherapy.

Complication	Description	Citation
Paradoxical Adipose Hyperplasia (PAH)	A rare adverse effect where, instead of reducing fat, cryotherapy leads to an increase in fat tissue in the treated area.	Ingargiola et al. [18]
Subcutaneous Emphysema	Application of cryotherapy over atrophic skin can cause air to become trapped under the skin, leading to swelling and discomfort.	Vano-Galvan et al. [22]
Chemotherapy-Induced Oral Thermal Hyperalgesia (OTH)	A common and debilitating side effect of platinum-based anticancer agents, characterized by increased sensitivity to thermal stimuli.	Imai et al. [19]
Skin Injury and Frostbite	Cryotherapy can cause frostbite and skin injuries due to prolonged or improper application of extreme cold temperatures.	Hirvonen et al. [20]
Nerve Damage	Nerve damage caused by improper or excessive cryotherapy, leading to complications such as neuropathic pain or loss of sensation.	Hooshmand and Phillips [21]

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DOI:10.26502/acmcr.96550701

as subcutaneous emphysema and pneumomediastinum, and emphasizes the need for careful procedural planning. Vano-Galvan et al. [22] reported a case of subcutaneous emphysema caused by cryotherapy applied to corticosteroid-induced atrophic skin. This case highlights the increased vulnerability of weakened or atrophic tissue to gas infiltration during cryotherapy. Corticosteroid-induced atrophy, with its reduced dermal thickness and compromised tissue integrity, may predispose patients to such complications. This serves as a reminder to consider the underlying characteristics of the tissue being treated when planning cryotherapy.

Lambert et al. [23] described subcutaneous emphysema resulting from liquid nitrogen spray used on the skin. Although spray cryotherapy is often viewed as less invasive than intralesional techniques, this case demonstrates that even non-intralesional applications can lead to serious complications under certain conditions, such as high-pressure delivery or lesions in anatomically sensitive areas. It underscores the importance of adjusting the cryogen application method based on lesion type, size, and location.

Gamboa Vidal et al. [24] reported a similar complication arising in the context of dental treatment. In this case, subcutaneous emphysema was not caused by cryotherapy but resulted from compressed air entering subcutaneous tissue during a dental procedure. While not directly related to cryotherapy, this case highlights the potential for air or gas to track through soft tissues and emphasizes the role of anatomical connections in the spread of gas to distant areas, including the mediastinum. These findings are relevant for understanding the pathophysiology of cryotherapy-induced complications and emphasize the anatomical predispositions that can exacerbate such issues.

Case Insights

The present case further adds to the body of evidence surrounding the rare but significant complications of cryotherapy. In our patient, intralesional cryotherapy was employed to treat a 30-year-old biopsy-proven keloid in the left scapular region. The lesion's chronicity and refractoriness to multiple previous treatments, including steroid injections and superficial cryotherapy, necessitated a more aggressive approach. However, the anatomical location near the thoracic inlet likely contributed to the development of subcutaneous emphysema and pneumomediastinum. The scapular region, with its proximity to fascial planes that communicate with the mediastinum, poses a higher risk for gas migration during cryotherapy.

Unlike the cases described by Vano-Galvan and Lambert, this patient underwent intralesional cryotherapy, where liquid nitrogen was injected directly into the lesion. This technique, while effective for thick or resistant lesions, increases the likelihood of complications due to the higher volumes and pressures of cryogen involved. The immediate onset of symptoms—pain, swelling, and dysphagia—underscores the rapidity with which complications can develop.

The successful conservative management of this patient highlights the importance of early diagnosis and intervention. Prompt recognition of subcutaneous crepitus during the physical examination and confirmation with thoracic CT ensured timely treatment. Prophylactic antibiotics, initiated to prevent mediastinitis, and oxygen therapy to facilitate gas absorption were effective, resulting in full recovery within a few days.

This case also raises critical questions about procedural modifications that could reduce risks. Could the outcome have been different if ultrasound guidance had been used to ensure more precise cryogen delivery? Collaboration with interventional radiologists may offer a more controlled approach to intralesional cryotherapy in high-risk anatomical areas. Furthermore, alternative techniques, such as combining superficial cryotherapy with steroid injections or using laser therapy, might be safer options for challenging lesions near sensitive regions.

Overall, this case underscores the need for a tailored approach to cryotherapy, taking into account lesion characteristics, anatomical location, and patient-specific risk factors. By learning from both the literature and individual cases, clinicians can refine their techniques to maximize therapeutic efficacy while minimizing complications.

Conclusion

This case highlights the potential risks associated with intralesional cryotherapy and underscores the importance of procedural planning and monitoring. By employing preventive measures such as imaging guidance, controlled cryogen delivery, and interdisciplinary collaboration, the risk of complications can be significantly reduced. Early diagnosis and conservative management of complications like subcutaneous emphysema and pneumomediastinum are crucial to ensuring patient safety and achieving optimal outcomes. Continued awareness and research are essential to refine cryotherapy techniques and enhance their safety profile, preserving this valuable tool in dermatological practice.

Ethics and Informed Consent Statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article. Ethical review and approval were not required to publish the case details in accordance with the institutional requirements.

Acknowledgments

The authors thank the patient who participated in this study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding: None

Disclosure

The authors report no conflicts of interest in this work.

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