



## Noninfectious Subcutaneous Emphysema of the Upper Extremity-Case Report and Review of the Literature

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### Abstract

Subcutaneous emphysema, defined as gas or air within the subcutaneous tissues is a rare diagnosis which may be attributed to trauma or surgery, perforation of respiratory or gastrointestinal tracts, high-pressure injection injury and factitious disorders.

We describe a case of benign subcutaneous emphysema caused by superficial non-penetrative trauma and the deferential from necrotizing fasciitis in order to avoid over treatment and secondary morbidity as a result.

### Keywords

Subcutaneous emphysema, Necrotizing fasciitis, Blunt trauma

### Introduction

Benign subcutaneous emphysema, defined as gas or air within the subcutaneous tissues is a rare diagnosis which may be attributed to trauma [1-3] or surgery [3,4], perforation of respiratory or gastro intestinal tracts [3-5], high-pressure injection injury and factitious disorders [3].

This entity is not associated with other systemic signs or symptoms and the patient usually appears well [6,7]. Pain is usually minimal as opposed to pain out of proportion described in case of necrotizing fasciitis [4,7] and no signs of vascular motor or sensory deficits are present [7]. Gas in the subcutaneous tissue that appears within 6-10 hours after the trauma is most likely from a benign cause since infection from a gas forming organism usually takes 12-18 hours to develop [6,8]. On x-ray studies air will be limited to the loose soft without edema of over lying skin and soft tissue, respecting tissue planes, muscle and deep fascia [8]. Laboratory test will show a normal white blood cell count and a mild to moderate elevation in C-reactive protein levels [7,9].

The diagnosis of benign subcutaneous emphysema should be one of exclusion and it is of utmost importance to rule out the presence of necrotizing fasciitis caused by gas

producing organisms. A neglect of a true infectious process leading to free air within the soft tissue may result in limb amputation or even death [3,9], while a misdiagnosis of a benign process as may lead to unnecessary surgery and secondary morbidity [3,10-12].

We describe a case of benign subcutaneous emphysema caused by superficial non-penetrative trauma treated conservatively.

### Case Report

A healthy 19-year-old presented to our emergency department after having been involved in a high energy motor vehicle accident. The patient sat in the car's front seat and was wearing a seat belt. On arrival he was fully conscious,

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**Figure 1:** A) Clinical image of the volar forearm and hand, on day injury; B) Lateral radiographs of the wrist and forearm demonstrating subcutaneous air on the dorsal aspect of the arm and wrist; C) Axial CT scan demonstrating swelling of soft tissues on dorsum of wrist bones and subcutaneous emphysema; D) Sagittal CT scan demonstrating swelling of soft tissues on dorsum of wrist bones and subcutaneous emphysema.

and complained of pain in his right forearm. All vital signs, including body temperature, blood pressure and pulse rate were within normal range. A large subcutaneous hematoma was noted on the volar aspect of the cubital fossa and the forearm, which was sensitive to touch. Other than mild skin abrasions on the dorso-radial aspect of the wrist, no skin lacerations or puncture wounds were evident (Figure 1A). Active elbow, wrist and finger ranges of motion were limited due to pain, so was the forearm pronation. Tactile sensation in the hand was normal, and capillary refill was similar to the contralateral hand. Laboratory tests demonstrated a white blood cell count of 6700/ $\mu$ L and a C-reactive protein level of 0.3 mg/dL (normal value, less than 0.5 mg/dL). Radiography showed no fractures, air was seen within the soft tissues on the dorsal aspect of the forearm and wrist (Figure 1B). Computed tomography demonstrated diffuse swelling of the dorsal soft tissues, localized subcutaneous emphysema around the dorsal aspect of the proximal and distal forearm, adjacent to the carpal and metacarpal bones, and within the extensor tendons retinaculum and tendon sheath (Figure 1C and Figure 1D).

The patient was admitted to the orthopedic ward for observation, the arm was kept elevated and cold com-

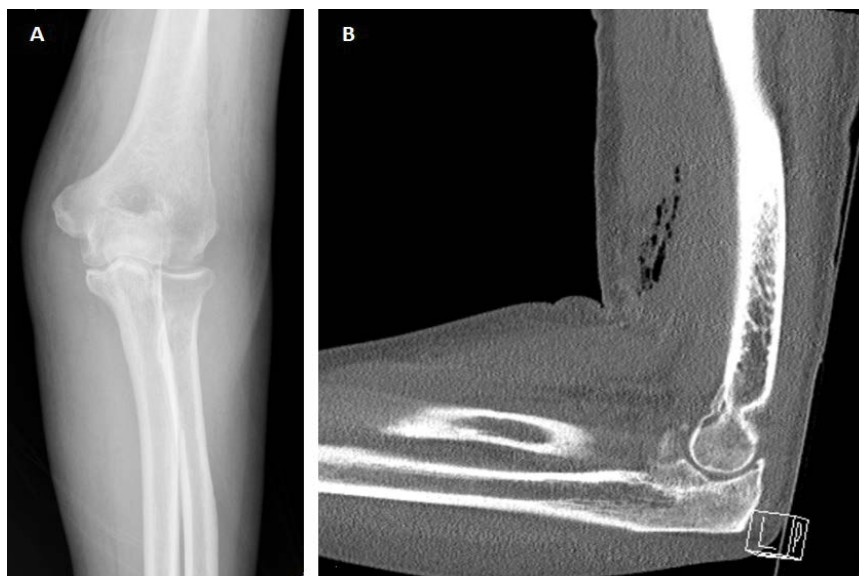
pression dressing was applied. The following day his pain subsided dramatically and forearm and hand motions improved. An ultrasound performed on the same day by a musculoskeletal imaging consultant showed that no air was trapped in the soft tissues. The patient was discharged 2 days after admittance, with compressive bandages applied to his forearm and fingers and began physical and occupational therapy in an outpatient setting. A week later during follow-up in the orthopedic trauma outpatient clinic, he reported significant range of motion improvement and painless motion. The swelling and hematoma around the forearm had subsided almost completely (Figure 2A). No air could be seen on plain x-ray images (Figure 2B) and repeat ultrasound demonstrated subsidence of the local swelling, and no emphysema in the soft tissues.

## Discussion

Benign subcutaneous emphysema caused by blunt trauma is a rare clinical entity, described in few case reports. Large amounts of air can enter the soft tissues from a small skin laceration or puncture wound, presumably as the result of a bivalve type mechanism allowing air to enter into the soft tissue [1-3,6,11].



**Figure 2:** A) Clinical image of the volar forearm and hand, 1 week after injury; B) Lateral radiographs of the wrist and forearm 1 week after injury.



**Figure 3:** A) Anterior-Posterior x-ray image demonstrating free air within muscle fibers in the distal arm; B) Sagittal CT scan in the same patient demonstrating pathological free air within the brachial is and biceps muscles clinically diagnosed as necrotizing fasciitis.

In the present case, aside from minor skin abrasions, no skin laceration or wound were found on clinical or radiologic examinations, emphasizing that the absence of an obvious point of entry does not exclude trauma as the cause of subcutaneous emphysema.

Necrotizing fasciitis (NF) accounts for 500 to 1000 cases annually in the United States with mortality rates of up-to 75% [10]. A patient presenting to the Emergency Department with crepitus on physical examination and subcutaneous gas on radiographs should be thoroughly evaluated since any delay in diagnosis and treatment

of NF increase significantly the morbidity and mortality [3,9]. On the other hand, a misdiagnosis of NF in a noninfectious case can lead to unnecessary surgery and resulting complications, such as scarring, late tissue adhesions, and potential surgical site infection [10-12].

A patient with benign soft tissue emphysema may present within 6 hours of injury as opposed to NF which takes more than 12-18 hours to develop [8,12]. The patient shows no signs of sepsis or toxemia and the clinical examination is normal aside from crepitus, local swelling, tenderness and erythema. White blood count (WBC),

inflammatory markers (C-reactive protein, CRP), renal function tests and electrolytes are within the normal limits. Imaging studies show air that is limited to loose areolar soft tissue and no gas is to be seen within the muscle or deep fascia [3,9,12].

On the contrary, a patient presenting with NF is usually ill appearing and may present with fever, chills, hypotension, and tachycardia [10]. Disproportionate pain has been suggested to be the most sensitive sign of NF and often the first one to develop. The involved extremity may show tense edema, bullae, skin discoloration. Sensory and motor deficit may also be present. Laboratory evaluation may show a rise in WBC ( $> 15.4 \times 10^9/L$ ), CRP ( $> 15$  mg/dl) and disrupted renal function studies which may include a rise in Creatinine (Cr) and Blood Urea Nitrogen (BUN) levels (Cr  $> 1.6$  mg/dl, BUN  $> 15$  mg/dl respectively) along with a decrease in sodium (Na) levels (Na  $< 135$  mmol/L) [9]. Simple X-ray images show gas within muscle bundles, with edema of overlaying skin and soft tissue (Figure 3A) [10]. Computer tomography scans may show asymmetrical fascial thickening with fat stranding and presence of gas (Figure 3B) [3,9]. Magnetic resonance studies are highly sensitive in diagnosis of NF, exhibiting liquefactive tissue necrosis and inflammatory edema along the fascial folds, appearing as an increased signal density on the T2-weighted images. Despite this, obtaining an MRI study should not delay treatment in cases highly suspected for NF. It should be reserved for a patient who is hemodynamically stable, presenting with a mixed clinical picture and in order to avoid unnecessary surgical treatment [3,10].

With a high degree of suspicion for NF, urgent surgical debridement is essential for reduction of bacterial load and necrotic tissue [10]. Empirical broad spectrum antibiotics with activity against gram-positive, gram-negative, and anaerobic organisms should be administered until the causative microbial agent is identified. Septic patients may require long term fluid resuscitation and blood pressure support [10].

However, if NF has been excluded, non-infectious subcutaneous emphysema should be treated non-operatively with close observation, limb elevation and in case of open wounds immobilization of the limb in order to avoid further air entrapment [2,12]. Broad spectrum antibiotics are recommended until NF has been completely

ruled out and are a reasonable course of treatment until blood cultures have returned negative [12].

As demonstrated in our case, lack of an obvious entry site is not enough to confirm or rule out a diagnosis of noninfectious subcutaneous emphysema. Close follow-up is of the essence in such cases as diagnosis of systemic symptoms or diagnostic tests confirm the development of a life threatening gas gangrene. If the condition follows a benign course, swift resolution is expected with simple conservative care.

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