Case Report

Blistering of the entire lower limb after knee arthroscopy: Benign Subcutaneous Emphysema, Gas Gangrene or Necrotizing Fasciitis? A case report and review of the literature

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Introduction

In arthroscopic surgery the overall complication rates vary from 0.5% to 2% [1–4]. The presence of gas or air in the subcutaneous tissue planes after surgery is rare but differential diagnosis range from benign to potentially life-threatening.

Gas Gangrene (GG) or Necrotizing Fasciitis (NF) are serious systemic conditions caused by gas forming organisms resulting in quickly spreading infection to subcutaneous and deep tissue planes. Gas Gangrene and Necrotizing Fasciitis require immediate and aggressive antibiotal and surgical treatment. In contrast, Benign Subcutaneous Emphysema (BSE) is mostly limited to subcutaneous planes and without systemic symptoms. It is rarely progressive and usually doesn't require any surgical treatment.

The detailed knowledge of symptoms, clinical and radiological appearance as well as a predefined treatment algorithm for BSE, GG or NF is of utmost importance and should be elucidated in this case report.

Case report

A 77-year-old, highly active female patient underwent arthroscopic knee surgery due to a meniscus rupture with persisting pain and locking sensation in her left knee. Ten days after surgery the patient returned with crepitus and palpable subcutaneous emphysema. A gaping lateral portal was revealed once the knee was in a flexed position. The patient complained of slight pain without any apparent clinical signs of infection. Blood analyses revealed a white blood cell count of 8.2 G/l (4–10) and a slightly elevated C-reactive protein of 1.01 mg/dl (0.0–0.05).

X-rays of the left lower extremity (Fig. 1) showed massive emphysema. In the CT scan a massive subcutaneous, intra- and intermuscular gas expansion, reaching from the Achilles tendon to the glutei muscles and inguinal region, (Figs. 2–6) was visible.

An early phase of a disease with gas producing bacteria was suspected and an emergency fasciotomy was performed. Soft tissue samples were retrieved and high dose antibiotic therapy was started during surgery. Intra-operative findings showed blistering at multiple locations of the thigh and lower leg but no tissue necrosis or signs of infection (Fig. 7). The muscles appeared to be vital and did contract spontaneously. Intra-operative microscopic analysis of deep tissue samples was negative for clostridia bacteria.

Four days after initial surgery the wounds were closed. Tissue samples, blood cultures and smears didn't reveal any pathological results. C-reactive protein increased to a maximum of 16.5 mg/dl timely related to surgery with a white blood cell count always in a

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Discussion

In the presented case a 77-year-old female patient developed massive subcutaneous emphysema three days after suture removal of two arthroscopic portals. After careful clinical and radiological examination, but under the wrong suspicion of an infection with gas producing bacteria, the patient was acutely treated with total fasciotomy of the left lower limb.

The primary learning objective of this case report is the early differential diagnosis of BSE, a rare but not life-threatening medical condition, from serious soft-tissue infections like GG or NF.

Benign Subcutaneous Emphysema following surgery is a rare but recognized complication, which should not be misinterpreted and can be treated conservatively. To the best of our knowledge, this is the first fully documented report of a massive benign subcutaneous and intramuscular gas appearance after suture removal following knee arthroscopy. A literature review revealed only a total of 43 cases of BSE due to low-grade injuries or following minimal invasive surgical procedures other than arthroscopy [5–35]. Other non-infectious causes for subcutaneous emphysema include injuries to the pulmonary tract or intestine e.g. from air guns or high-pressure devices, blast injuries, cutaneous ulcers, dental extractions, chemical reactions [36] or even self-induced emphysema [37,38].

Due to the mechanical genesis of the BSE, gas instillation usually starts immediately after the barrier of the skin is broken but can also be delayed for several days [39]. Especially in post-operative patients or patients who are immobilized after surgery, the development of BSE may take longer.
In the present case, the authors hypothesize that following early suture removal, the gaping arthroscopic portal acted like a one-way flap valve. When the knee joint was bent, air got trapped in the subcutaneous tissue which was then pressed in the subcutaneous and interfascial planes during extension.

If a patient presents with clinical or radiological findings similar to BSE, GG or NF (see Table 1), it is of utmost importance to have a clear and structured working path in order to avoid misinterpretations, since initial symptoms may be similar in all three conditions. As has been seen in this special case, but in contrast to typical radiological findings of BSE, gas must not be limited to subcutaneous levels. Probably due to fascial injury or perforation paired with high pressures produced by the continuous air entrapment by the valve mechanism, the gas can reach deeper tissue planes or even become intramuscular and therefore mimic radiological findings of GG or NF.

In the present case the massive subcutaneous, interfascial and intramuscular air was misinterpreted as the initial phase of a serious and life-threatening condition and the patients was treated accordingly.

In order to avoid similar cases in the future the authors recommend the following approach if a subcutaneous emphysema is
Fig. 3. Coronary CT slice at the level L1 showing gas in the gluteal muscles and lower pelvis.

Fig. 4. Coronary CT slice at the level L2 of the left thigh showing subcutaneous, intra- and intermuscular gas.

Fig. 5. Coronary CT slice at the level L3 of the left thigh showing gas instillation also intra articular.
diagnosed: first, an extensive anamnesis including the genesis of the wound and the timely relation to the development of the subcutaneous emphysema is essential. It is important to remember, that in immobilized patients the development of the emphysema might be delayed. In subjects with massive and/or worsening pain GG or NF must be suspected. Second, wound inspection should be performed and tissue samples should be taken for immediate gram staining and culture. An initial erythema with hardening of the skin and swelling beyond the area of skin change are the initial sign of a more serious condition. In the presence of a livid skin colour or even haemorrhagic blisters GG or NF is likely. Third, blood analysis including white blood cell count, sodium level and ureic acid should be obtained. Last, injuries of the airway system or the intestines need to be ruled out.

An infection with gas producing bacteria is unlikely a) if the wounds are unsuspicious and without any inflammatory skin changes, livid skin areas or haemorrhagic blisters, b) in the absence of severe pain or extreme tenderness, c) if no signs of toxicity or shock are present, d) if laboratory markers remain within the physiological range e) with preserved vigilance and f) if the emphysema is radiologically confined to subcutaneous regions and fascial planes without any signs of infection. In any other cases and if there is any doubt about the diagnosis, a surgical revision is indicated.

If a life-threatening disease was ruled out, patients should be observed for 24 h and treated with intravenous broad-spectrum antibiotics covering anaerobic and aerobic bacteria. Vital signs have to be monitored and serial examinations performed. Immobilization and elevation of the affected extremity is recommended to disrupt the valve mechanism and allow for absorption of the emphysema. If symptoms progress, especially with increasing pain, rise of laboratory markers or if the patient gets systemically unstable Gas Gangrene or Necrotizing Fasciitis has to be suspected and an immediate surgical exploration is recommended [39].
Conclusion

Benign Subcutaneous Emphysema (BSE) is a rare complication after minimal invasive surgical interventions including knee arthroscopy, which can commonly be treated conservatively. However, a detailed anamnesis, wound inspection, radiological examination using X-ray and CT scans as well laboratory markers and blood analysis are required to rule out any serious and life-threatening diseases like Gas Gangrene or Necrotizing Fasciitis.

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Informed consent was obtained from the patient.

CRediT authorship contribution statement

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Declaration of competing interest

The author(s) declare that they have no competing interests.

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