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Body Contouring

Case Report

The Perfect Storm: Fat Embolism Syndrome Following Liposuction, Helium Radiofrequency, and Targeted Cellulite Subcision

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Abstract

This is a case report of fat embolism syndrome (FES), where fatty micro-fragments lodge into pulmonary capillaries damaging alveoli and causing respiratory insufficiency immediately following the combination of liposuction, helium radiofrequency (HRF), and targeted cellulite subcision of the thighs in a 51-year-old woman. FES is to be distinguished from macroscopic fat embolism, which causes mechanical obstruction of venous vasculature and sudden cardiac failure. FES is the sequelae of microscopic fat emboli affecting the lungs, brain, and skin and is characterized by acute onset of hypoxia and a diffuse ground-glass appearance on computed tomography. In this report, the authors theorize the possible mechanism created by the combination of subcision, power-assisted liposuction, and HRF, which might have led to FES. They also share potential safety considerations when using these multiple modalities.

Level of Evidence: 5 (Therapeutic)

This is a case report of fat embolism syndrome (FES) immediately following the combination of liposuction, helium radiofrequency (HRF), and targeted cellulite subcision (TCS) of the thighs in a 51-year-old woman. FES is the sequelae of microscopic fat emboli and potentially affects the lungs, brain, liver, kidneys, skin, and circulatory system. FES is recognized as a triad of pulmonary dysfunction, altered mental status, and petechial rash. However, major criteria are not absolute; altered mental status occurs in 59% and rash in 20% to 33%, typically occurring in 24 to 48 h over the anterior thorax, axilla, head, and neck.[1-3] Minor criteria of FES include pyrexia, tachycardia, retinal changes, jaundice, and renal issues.[3] FES usually occurs within 3 days of long bone or pelvic fracture and acute onset (average 1.8 h) with liposuction.[4,5] In FES, laboratory tests usually show leukocytosis, neutrophilia, elevated D-dimer, decreased hemoglobin, and thrombocytopenia.[5] To date, there have only been 23 cases of liposuction-related FES reported in the literature and 40 cases of macroscopic fat embolism.[1,5,6] FES should not be confused with fat embolism, which is the result of macroscopic, mechanical obstruction of venous or pulmonary vasculature that causes sudden cardiac failure, typically following fat transfer.[7] Theoretically in FES, fatty micro-fragments lodge into the pulmonary capillaries where triglycerides are converted into toxic fatty acids that trigger inflammation and damage of the alveoli.[4] FES imaging usually shows bilateral diffuse homogeneous or heterogeneous opacities resembling pulmonary edema or acute respiratory distress syndrome also called "ground-glass" or micronodules on computed tomography (CT).[4,8,9] Treatment involves supportive care, providing continuous positive airway pressure, intubation with positive end expiratory pressure, and pharmacologic agents for hemodynamic stability.[5,10] Routine use of corticosteroids, anticoagulants, and prophylactic antibiotics has not been proven beneficial.[4,10] Survival of FES is reported to be 85% to 90%.[5,11]

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CASE PRESENTATION

The patient was a 51-year-old healthy woman with BMI of 24.1 who experienced FES immediately following TCS, power-assisted liposuction (PAL) and HRF of the thighs, and PAL and HRF of the lower back. She had a history of hypothyroidism and no history of varicose veins, massive weight loss, smoking, nor cardiopulmonary disease. The patient was prone and then supine for the procedure and had total intravenous (IV) anesthesia with laryngeal mask airway (LMA), IV fluid 3700 cc, tumescent 2875 cc, lipoaspirate 2350 cc, estimated blood loss <25 cc, and urine output 150 cc. The patient was spontaneously breathing with IV anesthesia throughout the case. The anesthesiologist used the LMA to keep the tongue out of the airway and block secretions from entering the airway. A foam-prone head positioner with tube access is used for supporting the head in the prone position. The targeted subcision of cellulite was performed on 23 total bilateral outer thigh dimples. The HRF setting was 1.5 L of helium gas flow and 80% radiofrequency energy, 5 passes were performed following liposuction with total energy per side 5.1 kJ inner/anterior thigh, 4.1 kJ lower back, and 2.5 kJ outer thigh. Gas was evacuated per manufacturer guidelines.[12] The patient had spontaneous breathing and stable vital signs throughout the case, and there were no episodes of coughing, laryngospasm, or bucking during or after the case. The patient was breathing room air and semi-recumbent for 45 min following uneventful removal of the LMA with normal vital signs. She was speaking, cooperative, alert, and oriented. Within 20 min of arriving in the recovery room, the patient became hypoxic with arterial oxygen saturation (SAO_2) 82% and tachycardic 118 beats per minute. Nasal cannula oxygen brought the SAO_2 up to 92% and an ambulance was called. Despite the hypoxia, she remained alert and oriented with no discomfort. She had clear breath sounds on auscultation and no pink, frothy sputum. Upon arrival at the emergency room, the patient was tachypneic with severe lactic acidosis of 5.3 mmol/L and a white blood cell (WBC) count of 24,000 with elevated neutrophils. The platelet count had dropped from 386,000 preoperatively to 270,000. D-dimer was not checked, and bronchoalveolar lavage was not performed. Testing ruled out *Staphylococcus pneumoniae* and Legionella antigen and COVID-19 RNA. CT of the chest demonstrated bilateral pulmonary consolidations with ground-glass opacity and reticulation in the upper and lower lobes (Video). She remained afebrile, and her WBC returned to 7000 within 24 h. Hematocrit started at 33 on admission. She received therapeutic doses of anticoagulation within 2 h of the liposuction, precipitating severe ecchymosis, and hematocrit dropped to 24. She received 3 days of step-down unit supportive care, including nasal cannula oxygen and respiratory therapy. She received ampicillin–sulbactam for prophylaxis of possible aspiration pneumonitis. There were no concerns with the surgical sites other than ecchymosis. She was placed on bed rest and received albumin since furosemide precipitated orthostatic hypotension. The echocardiogram showed a normal ejection fraction. A pulmonologist was consulted and diagnosed the patient with "lipoid pneumonia," secondary to liposuction. She was discharged home in stable condition with iron supplementation for acute anemia. This case report followed the principles of the Declaration of Helsinki.

DISCUSSION

Without an autopsy or bronchoalveolar lavage demonstrating lipids, the diagnosis of FES is one of exclusion in the setting of liposuction, severe respiratory distress, and ground-glass appearance of the lungs. Differential diagnoses include negative pressure pulmonary edema (NPPE), which usually involves endotracheal ventilation and presents with laryngospasm during intubation or extubation; aspiration pneumonia, which was unlikely with prone positioning and without swallowing oral intake; fluid overload, which was ruled out with a normal echocardiogram; and pneumonia.[12] NPPE from a strong inspiratory effort against a closed glottis is a possible differential diagnosis. However, the patient had regular effort and cadence of breathing during and after the case, and the LMA was removed without coughing, gagging, or spasming. Furthermore, she maintained normal vital signs for 45 min at room air and was speaking alertly and oriented before the development of tachycardia and hypoxia, whereas NPPE would typically have a more rapid decline immediately following extubation.[13] The limitations of this case report are that the diagnosis is a deduction barring pathological examination of the patient's lung tissue and the etiology is a premise.

The authors speculate that the cause of FES in this case was that the retractable blade for cellulite subcision inadvertently opened superficial veins, PAL micronized the fat, and helium gas increased interstitial pressure, pushing microscopic fat into circulation. Animal studies have demonstrated a 100% occurrence of pulmonary fat embolism with liposuction. In 6/6 pigs euthanized 10 to 48 h after liposuction, microscopic fat emboli were found in the pulmonary alveolar capillaries through oil red O stains and patchy pleural hemorrhages on gross pathology.[14] Kenkel et al hypothesized that subclinical FES may occur with every human liposuction, but the lungs clear the fat emboli; thus, FES is a rare complication of liposuction. Lim et al found pulmonary fat embolism in 15/15 of rats and cerebral fat embolism in 2/15 following liposuction.[15] El-Ali and Gourlay found pulmonary embolism in 10/10 of rats and cerebral fat embolism in 1/10.[16] In humans, fat embolism to the brain after liposuction has been reported twice, secondary to either a patent foramen ovale, pulmonary arteriovenous microfistula, or fat microglobules crossing the

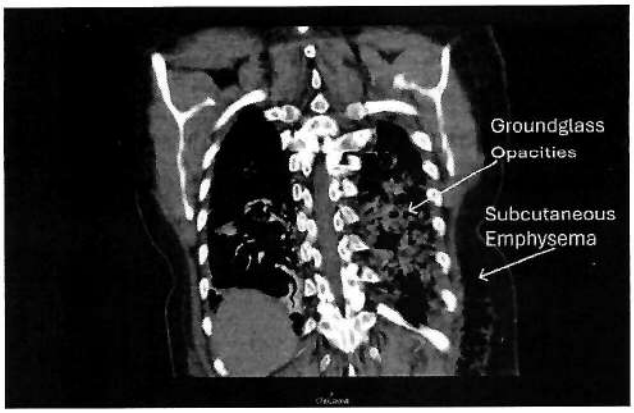

Figure 1. Single coronal view of the chest computed tomography scan of a 51-year-old woman demonstrating severe subcutaneous emphysema and bilateral pulmonary consolidation with ground-glass opacities, immediately following targeted cellulite subcision, power-assisted liposuction (PAL), and helium radiofrequency (HRF) of the thighs and PAL, and HRF of the lower back. See Video for additional views.

pulmonary capillaries.[17,18] Franco et al studied liposuction in a controlled, experimental model and found fat particles in the lungs of 3/10 rats after liposuction and 6/10 rats after receiving fat grafting compared with 0/10 of controls.[19] Given the high occurrence of FES in animals after liposuction, FES may be underestimated in humans and may manifest as nonspecific symptoms, such as tachycardia, elevated temperature, and tachypnea.[20]

Liposuction itself may be the etiology of FES, and the use of TCS and HRF may be coincidental, not causal, events. Dehydration and higher lipoaspirate volume purportedly increase the risk of FES.[11] However, the patient was 4 L positive in fluid balance, and the lipoaspirate was low volume. Avéli (Revelle Aesthetics, Mountain View, CA) involves targeted verifiable subcision of cellulite in the buttocks and outer thighs, with 93.9% of patients with an improved global aesthetic improvement scale at 12 months.[21] Ecchymosis is the most common side effect of TCS and signals the leaking of damaged blood vessels. Renuvion (Apyx Medical, Clearwater, FL) involves the thermocoagulation of fibroseptal connective tissue to 85°C with simultaneous helium gas cooling for safe and effective shrinkage of skin following liposuction.[22] Helium gas is an inert, nontoxic gas that is lighter than air, oxygen, and nitrogen and tends to migrate, as exhibited in the extensive subcutaneous emphysema seen on the patient's CT scan (Figure 1). Usually, residual helium gas leads to a self-limiting, nonpainful subcutaneous emphysema that resolves within days.

Nevertheless, adverse pulmonary events with HRF have been reported. The FDA Maude database lists 11 cases of pulmonary events, including pneumothorax, pneumomediastinum, and gas embolism, in conjunction with Renuvion.[23] Three cases of pneumomediastinum and widespread subcutaneous emphysema occurring after HRF have been described in peer-reviewed literature.[24-26] Pneumomediastinum presents with pain, a crunching sound on auscultation of the heartbeat, and cardiovascular compromise.[26] Emphysema tracking to the neck causes crepitus, dysphasia, and dysarthria.[26] Apyx Medical post-market surveillance determined the incidence of pneumomediastinum/pneumothorax/pneumoperitoneum with HRF to be 0.009% and fat embolism (suspected not confirmed) 0.001% (n=150,498), these rates are lower than those previously published on liposuction.[27]

Medical gases such as nitrous oxide, nitrogen, helium, air, and carbon dioxide can cause gas embolism. The incidence of air embolism in surgical procedures is exceedingly rare; a study of 2.2 million patients reported a rate of 0.57 per 100,000 endoscopic procedures.[28] A meta-analysis of laparoscopic surgery found a similar rate of carbon dioxide embolism, 0.001% among 489,335 patients.[29] Venous gas embolism would show air in pulmonary vasculature on CT scan.[6] Immediate treatment of gas embolism includes the left lateral decubitus position with the head down to avoid brain embolism.[4] Pneumomediastinum and gas embolism in the absence of pneumothorax have been treated with hyperbaric oxygen to consolidate and diffuse the gas, providing immediate pain relief.[26,30]

Microscopic fat embolism probably occurs more often with liposuction than reported in the literature. Combining liposuction with devices enhances results and avoids complications of excisional surgery, but not without added risk. Following HRF, egress of the helium gas is critical with ample incision width, adequate pretunneling, and manual expression. To minimize residual gas, the senior author recommends a brief pass of liposuction be done at the conclusion of HRF. Furthermore, the manufacturer could consider modifying the handpiece to evacuate helium in real time. In an abundance of caution, transfer of fat or injection of dermal filler into the buttocks and outer thighs could be staged to eliminate the risk of the infusion entering blood vessels sheared by TCS.

CONCLUSIONS

Avéli and Renuvion are effective and generally safe devices, but caution is advised with combining TCS, liposuction, and HRF in the outer thighs subsequent to this case of FES.

Supplemental Material

This article contains supplemental material located online at https://doi.org/10.1093/asjof/ojaf045.

Disclosures

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