Silicon Embolization Syndrome - A Diagnostic and Therapeutic Dilemma: A Case Series and Review of the Literature

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ABBREVIATIONS:

M: Male; F: Female; T: transexual; I/V: intravenous; B/L: bilateral; O2: oxygen; S: survived; E: expired; SES: Silicon Embolization Syndrome

ABSTRACT

In scientific literature, silicone embolization syndrome has been well described and multiple presentations have been delineated. The use of non-medical injections of silicone has become very popular with the public in general, in particular with certain groups that are highly focused on their physical image. Local effects including tissue necrosis, foreign body giant cell reaction, and community-acquired infection have been commonly recorded. Distal effects suggesting an embolic phenomenon can present as regional lymphadenopathy, granulomatous hepatitis, interstitial nephritis, and other acute systemic illnesses. But pulmonary and neurologic sequelae especially warrant emergency attention and can be fatal, if not identified immediately. Pulmonary manifestation can sometimes easily mimic bilateral pneumonia, especially if there is no suspicion for illicit silicone use, which was the case with our patients. The injected subcutaneous silicone migrated rapidly from the interstitial subcutaneous tissue into the general bloodstream resulting in systemic silicone embolization. An analysis of the presented case in conjunction with a review of the pertinent medical literature, including relevant case reports revealed the common clinicopathologic manifestations of silicon embolism.

INTRODUCTION

Liquid injectable silicone (purified polydimethylsiloxane) is a liquid polymer widely used for cosmetic augmentation of soft tissues. Its permanent, non-antigenic, temperature resistant and noncarcinogenic nature made it an ideal implantable substance (1). However, it is not as completely inert as once thought and is often associated with serious local and systematic complications (2). The local effects include tissue necrosis, foreign body giant cell reactions, and infection. Distal effects suggesting an embolic phenomenon can present as regional lymphadenopathy, granulomatous hepatitis, interstitial nephritis, and other acute systemic illnesses(2-5). In the United States, liquid silicone is FDA approved only for intraocular use but its off-label and illicit usage has been widely reported in Asian females, sex workers, transsexual and transgender individuals. They often self-inject liquid silicon to augment their cosmetic features and present with serious complications associated with its usage, including pulmonary reactions, granuloma formations, and embolization to other organs(5). Here we report two cases of Silicon embolization to pulmonary vasculature mimicking bilateral pneumonia.

MATERIALS AND METHODS:

OBJECTIVE: The review was done to study the plethora of complications and clinical outcomes associated with the injection of liquid silicone in different parts of the body, known as the Silicon Embolization Syndrome.

DATABASES: The literature review for the research was performed on PubMed and Cochrane. Mesh terms, "Silicon", "injection", "subcutaneous", "complications", "pneumonitis", "embolization", were searched with all corresponding keywords and relevant articles were imported into Endnote. Moreover, we used the bibliographies of literature retrieved via a search of authoritative texts and hand searches on google scholar, making sure we do not miss any articles. All keywords are shown in Table 1.

INCLUSION CRITERIA:

1: All case reports of silicon embolization were included

2: Case series and Editorials

3: Studies published in the English Language

EXCLUSION CRITERIA:

1: Studies published in languages other than English.

2: Review studies

3: case studies that did not mention complications

STUDY SELECTION: A total of 134 studies was imported into Endnote from the 2 databases. Inclusion and exclusion criteria were applied and a total of 44 articles was selected after going through titles and abstracts. These 44 full articles were extracted and independently passed through the quality assessment questionnaire to finally select a total of 21 articles that have been included in the final review. Figure 1 shows the PRISMA flow chart of study selection.

DATA EXTRACTION: Data extraction was done from selected studies in tabulated form. Extraction of data was performed by the same review authors who conducted the study selection independently, using a structured form that contained study characteristics, including the age of the patients, presence of fever, presenting symptoms, vitals, CT scan findings, and management. Any disagreement was discussed after completion of the data collection process and reviewers were consulted for each topic.

CASE 1:

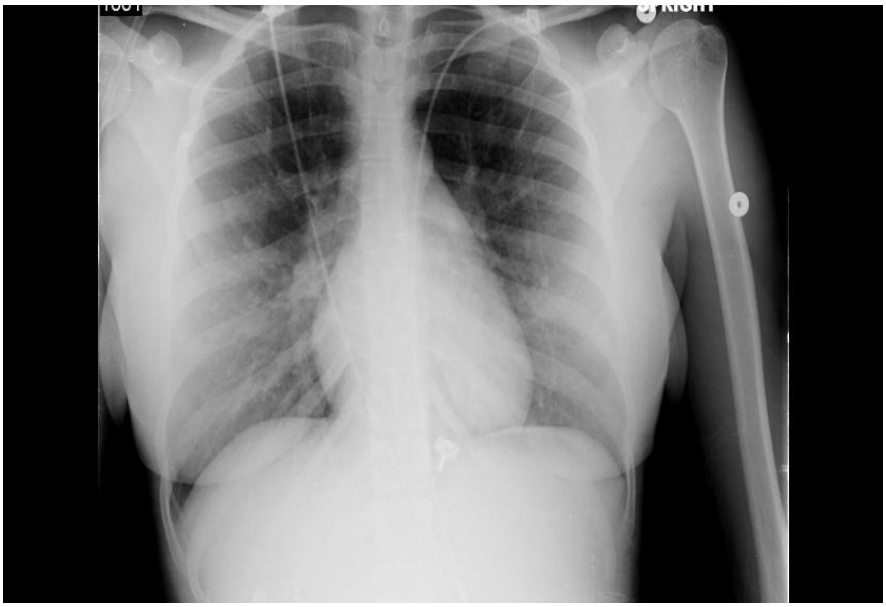
A 25-year-old female with a past medical history of bipolar disorder and anxiety disorder presented to our ED with complaints of fever, shortness of breath & generalized weakness for 1 week. In the ED patient was found to be tachycardic, tachypneic, and anxious on initial evaluation. She was advised to get admitted for further workup but the patient decided to leave against medical advice. The patient was sent to our ED on the next day from the crisis center due to hypoxia. Earlier that day patient went to the crisis center thinking that her symptoms were related to her anxiety disorder with a panic attack. The patient was complaining of chest heaviness along with generalized weakness & shortness of breath. She was again found to be tachycardic, febrile (100.5 F), and moderate to severe respiratory distress with tachypnea. Chest examination revealed bibasilar rhonchi. The patient was saturating 87% on room air and 93 % on 5 liters of oxygen via nasal cannula. Given her respiratory distress and impending respiratory failure, the patient was intubated and mechanically ventilated. She was noted to have mild bleeding via the endotracheal tube which was suctioned out. The patient was adequately sedated to prevent any further injury. Chest x-ray showed bilateral lower lobe dense consolidations and pleural effusions concerning pneumonia. CT chest showed severe bilateral consolidative changes that were most prominent in the bilateral lower lobes. The patient was admitted to ICU and was managed initially with IV antibiotics for community-acquired pneumonia. She was not responding well to IV antibiotics. Further physical examination in the ICU showed multiple tattoos and granulomatous patches in her buttocks. CT chest scan was again confirmed with the radiologist who suggested the findings may also be found in silicon embolization syndrome. With clinical deterioration and no response to IV antibiotics, IV steroids were subsequently started with dramatic improvement leading to clinical recovery and successful extubation.

CASE 2:

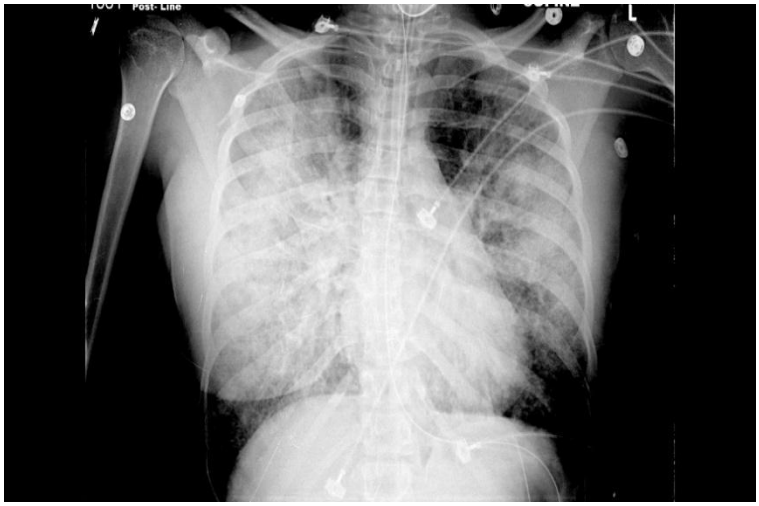
A 20-year-old British female with no significant past medical history presented to the emergency room with complaints of shortness of breath and chest pain. The patient arrived from a hotel located close to an airport after she suddenly started with symptoms. The patient was noted to have mild apparent respiratory distress and occasional rales bilaterally in the ED. She underwent EKG which showed normal sinus rhythm. The initial chest X-ray showed some alveolar infiltrates. The patient was started on IV antibiotics

to cover for community-acquired pneumonia including atypical coverage with macrolides. Initial vital signs were stable with BP 107/59 mmHg, HR 96/min, RR 20/min, and temperature 96.4 F. Initial lab results were significant for the mild elevation of D-dimer with negative troponins, normal white count, and normal serum chemistry. Given her bilateral infiltrates on chest x-ray, the patient underwent CT angiography of the chest. CTA chest was negative for pulmonary embolism but did show peripherally located ground-glass opacities. V/Q scan showed a decrease in peripheral uptake without segmental. She was admitted to the hospital for further care but her condition worsened in the next 24 hours. The patient became tachypneic with a respiratory rate of 38/min, tachycardiac with a heart rate of 118/min, temperature 100.3F, and hypoxemic. Labs were repeated which showed leukocytosis (19,000), elevated lactic acid to 5 mg/dl, and troponin elevation of 0.42. Given her hypoxemic and severe respiratory distress, the patient was intubated and mechanically ventilated. Chest x-ray post-intubation showed diffuse patchy alveolar infiltrates that were much worse when compared to prior. Due to rapid clinical deterioration with worsening hypoxemia patient had a cardiac arrest with prolonged but eventually unsuccessful resuscitation. Post-autopsy results showed lung biopsy specimen positive for vacuolated globular deposits of silicone in the interstitial capillaries, interalveolar walls, and macrophages. The patient suffered from silicon embolization syndrome.

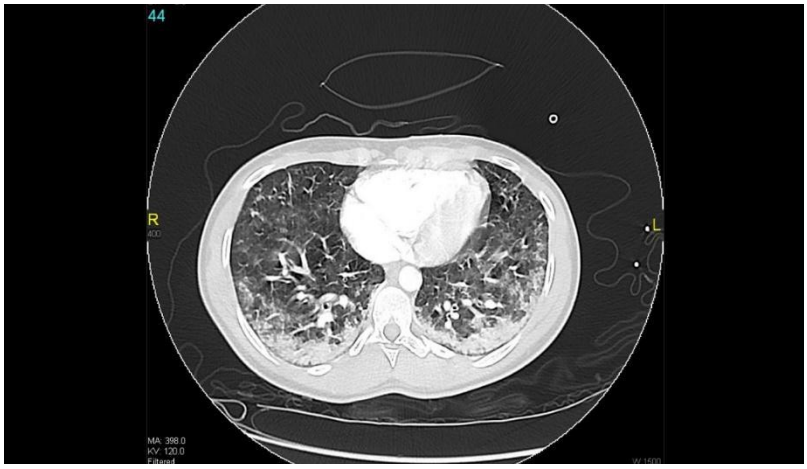
CASE 2: Initial CXR with occasional bilateral infiltrates.

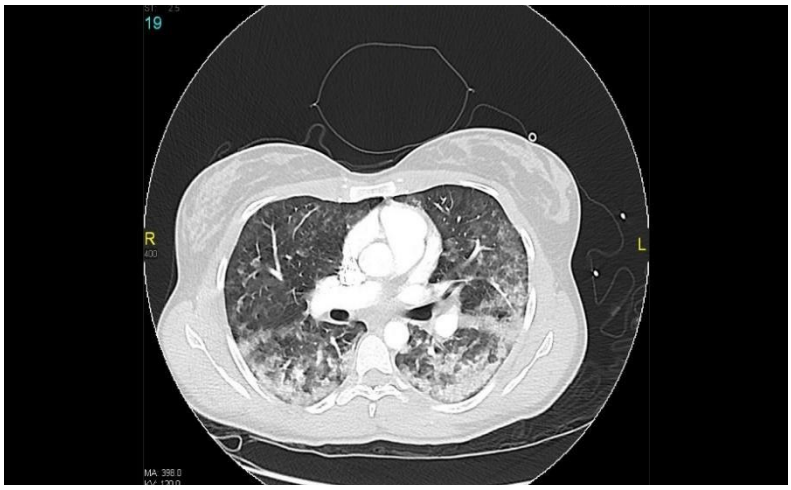


Case 2: CXR Post-Intubation showing diffuse patchy alveolar infiltrates.



Case 2: CT chest shows ground-glass opacities distributed in a peripheral pattern.





RESULTS

A total of 21 studies were included in our review with N=55 patients. There were 33 transsexual men, 20 women, and 2 men. The mean age was 21.6 years. The most common sites of silicone injection were breast (n=37), trochanteric area (n =22), vagina (n=7), hip (n=24), and shoulder (n=3). One patient developed symptoms after 7 years of breast implant and other patients developed symptoms significantly soon after silicone implantation. The onset of clinical signs occurred within 24 h of injection in n =19 patients, n= 23 presented within 24 to 72 hours while n=2 presented after a week. The major clinical findings were: fever (n=24); cough (n=18); pleuritic pain (n=6); hemoptysis (n=21); dyspnea (n=22) and shortness of breath (n=4). Other findings are listed in table 1.

The chest radiographs showed bilateral alveolar infiltrates (n=30); consolidation (n=25); ground glass opacities (n=10). The radiographical data for n=4 patients was not available. Alveolar hemorrhage, (n=12), inclusions in alveolar macrophages (n=24), silicon emboli n=8 and silicon granulomas n=2 was reported on pathological examination.

The most common mainstay of treatment was steroids n=13 and oxygen n=13 followed by antibiotics n=7. After hospitalization and initiation of proper treatment n=46 survived while it proved to be fatal for n=9 patients.

DISCUSSION

Silicon has been long used as a soft tissue substitute for plastic and reconstructive surgery. Unfortunately, the illicit use of silicone injections by uncertified practitioners is not uncommon(6). The use of liquid silicone for cosmetic enhancement is an illegal practice that was initiated in Asia and later introduced in Europe among people who were unable to afford the cost of plastic surgery (2). It is known that the subcutaneous administration of silicon for tissue augmentation is associated with a spectrum of severe complications known as the "Silicon Embolization Syndrome", which includes signs and symptoms of dyspnea, fever, cough, hemoptysis, chest pain, hypoxia, alveolar hemorrhage, and altered consciousness (7). Silicon Embolization Syndrome (SES) was first described in groups of transsexual men who received serial injections for breast augmentation in the 1970s. Later studies included young women who sought low-cost tissue augmentation (4).

Although the precise mechanism of silicon toxicity is still unclear, one theory suggests that small particles of silicone gradually diffuse into the circulatory system with subsequent embolization to the lungs (8). It is also postulated that there are two prominent clinical presentations, one with predominant signs of pulmonary toxicity from which most patients recover and a second dominated mostly by neurologic toxicity where most of the cases resulted in death (9). Further, two forms of pneumonitis have been described. An acute form, which occurs immediately or a few days post-injection, and consists of sudden onset of shortness of breath, fever, mild to moderate hypoxemia, tachycardia, and occasionally, acute respiratory failure. A delayed-onset of pneumonitis appears up to 6 months after the last silicone injection. These patients typically present with local swelling at the injection site and milder respiratory symptoms (2).

Chung et al have reported multiple microscopic findings, including silicone emboli, intra-alveolar hemorrhages, and foreign body reactions. Therefore, the author concluded that silicone injections can produce acute pulmonary disease within a few hours after injection. This supports the assumption that silicone fluid injections result in local tissue damage and silicone eventually gains access to the bloodstream to cause embolization in the lung (6). Four histological patterns have been described in silicone lung injury: (a) presence of silicone emboli, (b) congestion and alveolar hemorrhage, (c) acute pneumonitis, and (d) diffuse alveolar hemorrhage. In some cases, silicone deposits in small vessels can increase pulmonary artery pressures sufficiently to cause cor pulmonale. The extent of pulmonary vascular bed obliteration determines the clinical status of the patient (2).

Schmid et al described the similarities between the presentation of patients with fat embolism and silicone embolism and deduced that the pathogenesis may be similar. In fat embolism, histologic examination of the lungs shows diffuse alveolar damage with fat globules in the pulmonary microcirculation. As macrophages ingest silicone, an inflammatory response occurs, activating endothelial cells, increasing capillary permeability, and modulating immunoregulatory responses in the alveoli (7). While the overall mortality associated with SES varies between 24 and 33%, the neurologic complications were found to be universally fatal. Autopsies performed in patients with neurologic findings demonstrate microinfarcts in brain white matter, which proved to be microparticles of silicone (7).

The treatment is usually rest, high-flow oxygen inhalation, and mechanical ventilation in some cases. Early corticosteroid treatment might help reverse the clinical course. Patients usually recover without sequelae, but pulmonary fibrosis has been described in patients who survive an acute event (2).

While legitimate plastic surgeons rarely practice liquid silicone injections, there is a growing trend of illicit cosmetic surgery in the United States and abroad. These sessions often involve the improper use of illegal substances under quasi-sterile conditions. The indexed cases also showed signs of pulmonary damage after silicone injections into the buttocks resulting in systemic embolization. These cases highlight a serious complication of an innocuous process, of which clinicians should be made aware. When acute respiratory failure occurs in patients with a history of cosmetic procedures for tissue augmentation or correction of contour, silicone embolism should be included in the differential diagnosis. SES should be suspected in patients with a history of liquid silicone injections who present with neurologic or pulmonary symptoms. Even in the absence of pulmonary or neurologic complications, it is important to note that liquid silicone, once injected, cannot be completely removed. Therefore, injected sites will remain a potential source of future infection or inflammation (4).

CONCLUSION

Silicon embolization syndrome should always be considered in patients who fail to respond to conventional treatments and show a rapid decline in clinical status. Patients with silicon embolization in the lungs show increasing respiratory distress with worsening hypoxic respiratory failure despite the initiation of antibiotics with the onset of symptoms. One case showed dramatic improvement with the initiation of systemic steroids on radiologic suspicion of silicon embolization. Failure to recognize silicon embolization early in the course may be fatal as seen with our second case. Chest imaging with bilateral opacities and clinical evidence of respiratory distress in young females should always have a suspicion of silicon embolization syndrome. History and physical examination are of paramount importance in such cases. These patients usually present with signs and symptoms suggestive of multifocal pneumonia and fail to respond to IV antibiotics. Even after recognizing such cases early in their course, some patients may require extracorporeal membrane oxygenation (ECMO) to maintain oxygenation.

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iii. **Ethics approva**l (N/A)

iv. **Consent to participate** (N/A)

v. **Consent for publication**: Proper informed consent was taken from the participants and were ensured their privacy of personal information.

vi. **Availability of data and material** N/A

vii**. Code availability** N/A

viii. **Authors' contributions: All authors equally participated in substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; drafting the article or revising it critically for important intellectual content; and final approval of the version to be published.**

REFERENCES

1. Narins RS, Beer K. Liquid injectable silicone: a review of its history, immunology, technical considerations, complications, and potential. Plastic and reconstructive surgery. 2006;118(3 Suppl):77s-84s.
2. Parikh R, Karim K, Parikh N, Han P, Daoko J, Shamoon FE. Case report and literature review: acute pneumonitis and alveolar hemorrhage after subcutaneous injection of liquid silicone. Annals of clinical and laboratory science. 2008;38(4):380-5.
3. Purdy-Payne EK, Green J, Zenoni S, Evans AN, Bilski TR. A Serious Complication of Illicit Silicone Injections: Latent Silicone Embolization Syndrome after Incision and Drainage of Local Injection Site. Surgical infections. 2015;16(4):473-7.
4. Bartsich S, Wu JK. Silicon emboli syndrome: a sequela of clandestine liquid silicone injections. A case report and review of the literature. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2010;63(1):e1-e3.

5. Lemperle G, Romano JJ, Busso M. Soft tissue augmentation with Artecoll: 10‐year history, indications, techniques, and complications. Dermatologic Surgery. 2003;29(6):573-87.
6. Chung KY, Kim SH, Kwon IH, Choi YS, Noh TW, Kwon TJ, et al. Clinicopathologic review of pulmonary silicone embolism with special emphasis on the resultant histologic diversity in the lung--a review of five cases. Yonsei medical journal. 2002;43(2):152-9.
7. Schmid A, Krieger B, A T, L l. Silicone embolism syndrome: a case report, review of the literature, and comparison with fat embolism syndrome. 2005.
8. Clark RF, Cantrell FL, Pacal A, Chen W, Betten DP. Subcutaneous silicone injection leading to multi-system organ failure. Clinical toxicology (Philadelphia, Pa). 2008;46(9):834-7.
9. Chastre J, Basset F, Viau F, Dournovo P, Bouchama A, Akesbi A, et al. Acute pneumonitis after subcutaneous injections of silicone in transsexual men. The New England journal of medicine. 1983;308(13):764-7.