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Breast Surgery

Case Report

Accidental Magnetic Resonance Imaging Activation of Carbon Dioxide Tissue Expanders

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Abstract

Implant-based reconstruction is the most common form of breast reconstruction following mastectomy. It is most often performed in 2 stages using saline-based tissue expanders, which are then exchanged for permanent implants. Serial expansions are performed by accessing a port in the office, an inconvenient and sometimes painful process. A carbon dioxide tissue expander is a device that provides a needle-free, patient-controlled expansion utilizing a remote-controlled CO_2 canister. While a patient-controlled expansion offers convenience, given that the CO_2 reservoir holds approximately 1500 mL of gas, the potential for malfunction resulting in an uncontrolled expansion in unique to this device. The authors present a case report of a patient with bilateral pre-pectoral tissue expanders who underwent magnetic resonance imaging, resulting in uncontrolled expansion.

Level of Evidence: 5

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Breast cancer is the most common malignancy in women with a lifetime incidence of 12%.[1] Forty-two percent of women will choose to have reconstructive surgery after a mastectomy, a process that often immediately follows the ablative procedure.[2,3] The most common method of reconstruction is 2-stage alloplastic reconstruction in which tissue expanders are placed with subsequent exchange to permanent implants.[4] Tissue expanders are temporary devices designed to create a breast pocket suitable for the placement of permanent prostheses. The expander can be placed in a pre-pectoral or subpectoral position. The patient then undergoes serial expansions where saline is instilled into the device using a fill port, a process that usually takes 3 to 6 months to complete.[5,6] The expansion process is often inconvenient, with patients undergoing multiple injections with risks including infection and damage to the prosthesis. The carbon dioxide expander was introduced with the potential to obviate some of these risks.

The AeroForm tissue expander (AirXpander, Inc., San Jose, CA) was approved by the FDA in 2016 and introduced a new paradigm to 2-staged implant-based breast reconstruction. The device offers many advantages when

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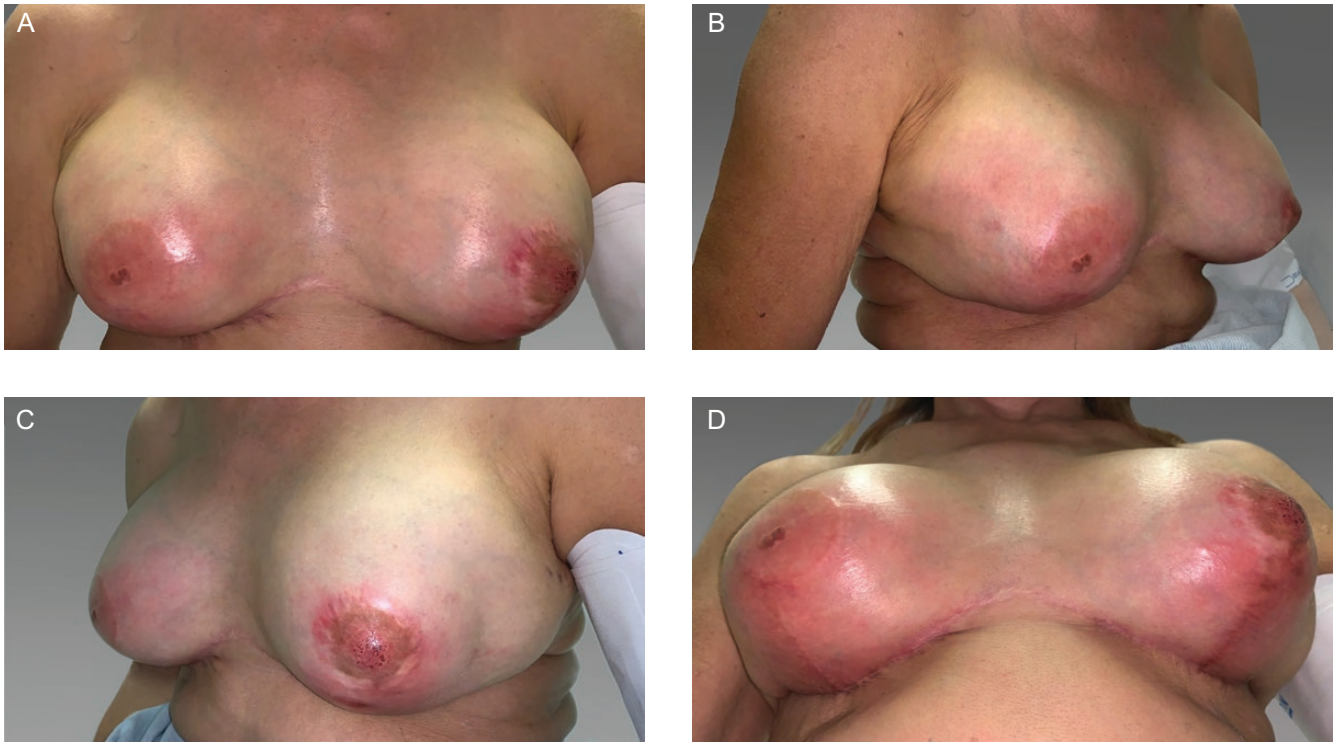

Figure 1. (A) Anterior, (B, C) oblique, and (D) inferior views of 70-year-old female patient postoperative day 73 from the placement of pre-pectoral AirXpanders for staged breast reconstruction revision. She presented to the emergency room 72 hours after exposure to MRI with a chief complaint of progressive increase in the size of her breasts and chest pain.

compared with saline expanders, including a patient-controlled, needle-free expansion experience that is often associated with a shorter expansion time.[7] The AeroForm AirXpander System is filled with carbon dioxide using a remote control that activates a stainless-steel canister containing compressed carbon dioxide.[8] This allows the expansion process to be performed at home by the patient. The patient can self-expand up to 3 times a day, with each expansion adding 10 mL of volume. This gradual expansion process has proven to have several advantages over traditional saline expansion: less painful expansions, no need for transcutaneous port access, lower infection risk, and shorter time to completion of entire expansion process with fewer visits to the surgeon's office.[9,10] Lower risk of infection is of particular clinical benefit as infection is the most common condition requiring tissue expander explantation, and these infections most often occur during the expansion phase.[11,12]

In addition, the AirXpander contains an electromagnet that makes it incompatible with magnetic resonance imaging (MRI). To date, there are no published reports discussing the outcomes of patients with AirXpanders in place who were exposed to an MRI magnetic field. We present a case of a patient with bilateral AirXpanders who underwent a diagnostic MRI and suffered accidental, uncontrolled expansion that required procedural intervention.

CASE REPORT

A 68-year-old female was referred to our office with a history of right-sided breast cancer treated with right skin-sparing and left nipple-sparing mastectomies with immediate implant-based reconstruction performed in the Dominican Republic 25 years prior to presentation. She was unsatisfied with her reconstruction and suffered from significant aesthetic deformity and breast pain for which she presented to our office in December 2017.

Her examination was notable for bilateral Baker Grade III capsular contracture with significant animation deformity and retraction of the pectoralis major muscle into the axilla. She was also noted to have significant bilateral discrepancies in the height of her inferior mammary fold and breast projection. Following extensive counseling, she elected to undergo revision of her reconstruction with tissue expander placement. Due to insurance issues, her surgery was not performed until February 2019 at which time she underwent bilateral capsulectomies, re-attachment of the pectoralis major muscles, and placement of pre-pectoral small size AeroForm tissue expanders with final fill capacity volume being 400 mL. An acellular dermal matrix was utilized for soft tissue reinforcement.

The patient had an uncomplicated postoperative course and began expansion after 2 weeks. After 2 months, her

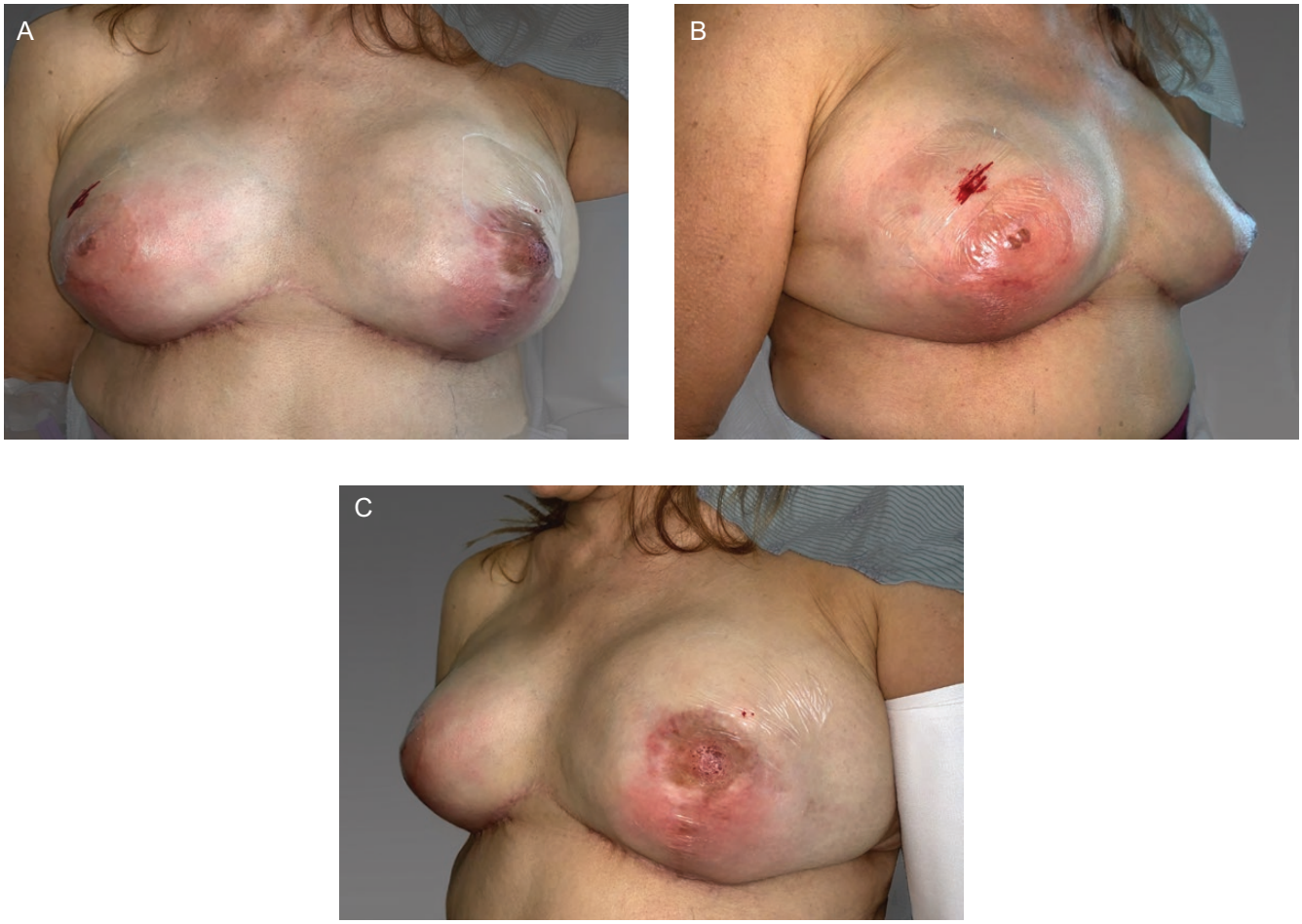

Figure 2. (A) Anterior and (B, C) oblique views of 70-year-old female patient postoperative day 73 from placement of pre-pectoral AirXpanders for staged breast reconstruction revision immediately following bedside needle decompression of AirXpanders in the emergency department. This was performed with an 18-gauge needle placed into the superior-lateral aspect of the breast. The needle puncture site was then covered with a transparent occlusive dressing.

expanders had been filled with 280 mL of carbon dioxide. During this time, the patient was undergoing evaluation for chronic headaches and nose bleeds by her private primary care provider who was not part of our university health system. The patient was referred for an MRI of the head unbeknownst to the plastic or breast surgery service. While undergoing the MRI, the patient experienced immediate chest pain and tightness along with a notable increase in breast size bilaterally. The examination was aborted, and the patient was transferred to a community hospital where she underwent work up for acute coronary syndrome and was discharged home after 2 days. She then presented to our hospital's emergency department due to persistent increase in the size of breasts and progressive chest pain. Both her breasts were very firm and tense with evidence of skin compromise and gradual increasing size of bilateral breasts (Figure 1) based on serial photographs provided by the family. She underwent bilateral tissue expander decompression with an 18-gauge needle at the bedside with immediate relief of pain (Figure 2).

She was discharged home after 2 days of observation; she subsequently returned for outpatient exchange of tissue expanders to 525 mL high profile silicone implants, 81 days after placement of AirXpanders, and 12 days after her MRI. She was satisfied with her aesthetic results and noted total resolution of her pain on follow up 5 months after tissue expander to implant exchange (Figure 3).

DISCUSSION

Prior work has illustrated the efficiency and efficacy of tissue expansion with carbon dioxide vs saline expanders.[9,10] Hsieh et al showed that the incidence of adverse events including infection and mastectomy flap necrosis occurred with greater frequency in the saline group 45.9% vs 32.4% the AeroForm group.[9] The carbon dioxide-based expander has proven to be a more comfortable method of tissue expansion with less frequency of infection rates and decreased utilization of healthcare and patient resources.[10]

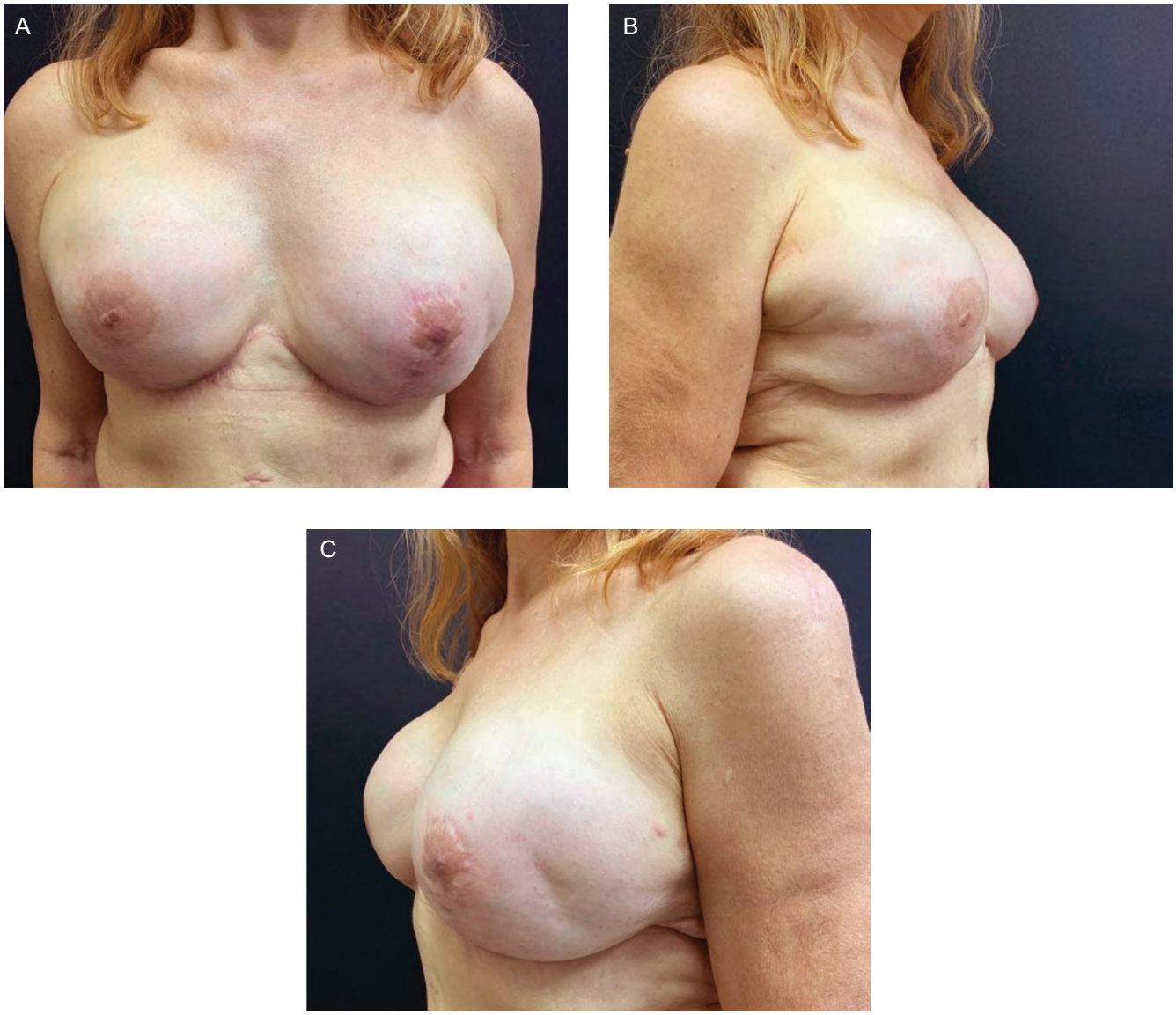

Figure 3. (A) Anterior and (B, C) oblique views of 70-year-old female patient 5 months postoperative from exchange of tissue expander to permanent implant.

Average time to completion of tissue expansion and subsequent breast reconstruction has been found to be significantly shorter.[7]

Studies have shown that the AirXpander is safe, with low device-related reconstruction failures. The XPAND randomized control trial treated 98 patients with 168 air expanders. Ninety-six percent successfully completed tissue expander exchange for implant with no device-related reconstruction failures.[7] Likewise, an Australian study reported no device-related reconstruction failures in 21 patients involving 34 air expanders.[13]

Regarding MRI compatibility, the AirXpander, such as its saline tissue expander counterparts, contains a magnetically active component. The AirXpander contains a solenoid-activated microvalve that controls the release of carbon dioxide from its carbon dioxide reservoir, rendering the AirXpander MRI-incompatible.[14] Likewise, saline tissue expanders contain an integrated magnetic port and are also labeled as MRI-incompatible by their manufacturers. However, MRI incompatibility of the saline expanders is not clinically absolute.[15] Thimmappa et al observed 71 patients who had tissue expanders with magnetic ports who underwent magnetic resonance angiography without any adverse effects.[16] A systematic review revealed only 3 cases reporting complications related to saline tissue expanders and MRI: 1 patient with dislodgement of the infusion port, 1 patient who experienced a burning sensation, and 1 patient who had developed delayed tissue expander exposure.[17]

In the presented case report, the patient experienced rapid spontaneous tissue expansion due to exposure to MRI. Per the manufacturer, the CO_2 reservoir contained within the AirXpander can hold as much as 1500 mL of compressed gas—well beyond the average implant volume of the reconstructed breast. Spontaneous expansion is unique to the AirXpander and when considering the future need for MRI exposure should be considered when deciding on the type of tissue expander to utilize for breast reconstruction. In the XPAND trial, there were 5 observed incidences of spontaneous over-inflation requiring needle decompression. The cause of over-inflation in these 5 cases was attributed to a design flaw of the valve regulating filling, which resulted in an uncontrolled release of CO_2 from the reservoir. However, during the later course of XPAND trial, an improved version of the device was utilized with modifications to the valve with no further valve-related issues reported.[7] As seen in this case, rapid, undesired expansion of the air expander can still occur during the initiation of MRI. Air expanders, unlike saline expanders, do not have a setting that allows for controlled deflation, and with uncontrolled expansion urgent needle decompression is warranted.

CONCLUSIONS

We have presented the only clinical scenario demonstrating spontaneous inflation of an air expander as a result of exposure to an MRI magnetic field. Although AirXpanders offer an effective and convenient alternative to traditional saline-filled expanders, they carry additional risks such as spontaneous over-inflation when exposed to MRI. Saline expanders, while labeled as MRI-incompatible, appear to be more compatible to MRI. MRI-compatibility should contribute to the decision-making process in selecting the most appropriate tissue expander for patients. Patients and physicians should be educated on the risk of over-inflation and the therapeutic value of needle decompression.

Disclosures

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