

Rupture of a breast tissue expander due to chest wall exostosis: Case report and literature review

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The incidence of device failure or rupture during tissue expansion is rare, and the etiology of device rupture is most commonly idiopathic; however, a multitude of potential etiologies have been reported including direct trauma, device over-expansion beyond manufacturer recommendations, capsular contracture, compressive forces during medical imaging studies, iatrogenic device damage during operative placement of the device or iatrogenic rupture during the process of filling the device. The authors report a case of device failure of the posterior wall of a tissue expander used for routine implant-based breast reconstruction that was attributed to bony exostosis of the anterior chest wall. They explore the relative incidence of bony exostosis-related and all-cause tissue expander rupture in peer-reviewed published literature. The present report illustrates the importance of evaluating the tissue quality of the periprosthetic capsule and pocket following a device failure to ensure that chest wall exostosis, a potential cause of further device failure, is not present.

Key Words: Breast reconstruction; Implant rupture; Tissue expander rupture; Tissue expansion

Tissue expanders are routinely used in a variety of reconstructive procedures. Typical of most established techniques, tissue expansion enjoys a relatively low complication rate, reported to be in the range of 10% (1). As the tissue expander is inflated, it creates pressure on the surrounding tissue, which, in rare circumstances, can contribute to osseous erosion, deformation and osteophyte formation. There are two case reports that implicate calvarial exostosis in expander deflation (2,3); however, there is no record in the literature of a costal osteophyte causing tissue expander rupture. Herein, we report a case involving an otherwise healthy 22-year-old woman undergoing tissue expansion for a routine implant-based breast reconstruction, who sustained a rupture of her tissue expander posterior wall, which we attribute to bony exostosis of the anterior chest wall.

CASE PRESENTATION

A 22-year-old woman presented to the plastic surgery department for immediate left breast reconstruction after mastectomy for malignant phyllodes tumour. A CPX tissue expander (Mentor, USA) was placed in a total submuscular pocket and expanded to 645 mL over a seven-month period. She did not undergo adjuvant chemotherapy or radiation therapy. Her final expansion volume was permitted to consolidate over six weeks. In the eighth month after placement of the expander, the patient noticed a dramatic decrease in volume (Figure 1). According to the patient, there was no associated trauma or

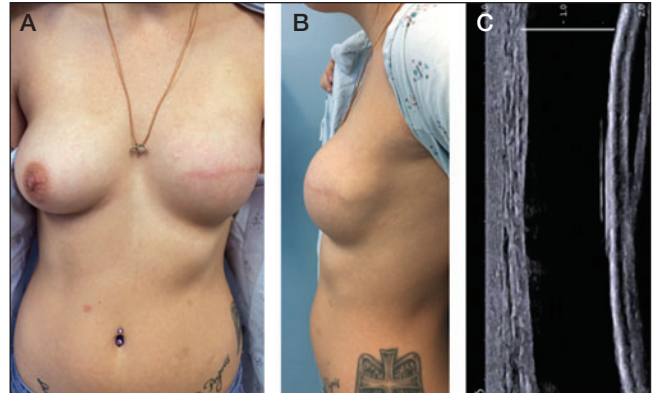


Figure 1) A and B Photographs taken at the time of detection of suspected device rupture. C Representative image of left breast ultrasound demonstrating periprosthetic fluid and deflated tissue expander consistent with device rupture

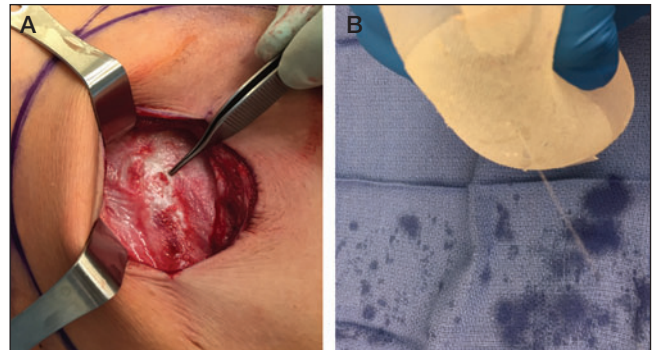


Figure 2) A Intraoperative photograph demonstrating anteromedial chest wall exostosis. B Intraoperative photograph demonstrating device rupture at the site of the chest wall exostosis

abnormal activity. Physical examination confirmed partial rupture of her tissue expander and she was taken urgently to the operating room for replacement of the ruptured expander with a permanent silicone implant. The posterior wall of the expander was perforated, directly overlying an area of bony exostosis along the anterior surface of the fifth rib (Figure 2). The exostosis was filed to a smooth surface with a surgical rasp and a permanent round Mentor 425 mL silicone implant was placed. The patient recovered uneventfully from her expander-implant exchange. At six months' follow-up, she has no signs of implant rupture or malposition and is pleased with her reconstruction (Figure 3).

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TABLE 1
Included studies classified according to level of evidence rating

Level of evidence	Qualifying studies	n (%)
I	High-quality, multicentre or single-centre, randomized controlled trial with adequate power; or systematic review of these studies	3 (4.6)
II	Lesser-quality, randomized controlled trial; prospective cohort or comparative study; or systematic review of these studies	2 (3.1)
III	Retrospective cohort or comparative study; case-control study; systematic review of these studies	6 (9.2)
IV	Case series with pre/post test or only post test	25 (38.5)
V	Expert opinion developed via consensus process; case report or clinical example; or evidence based on physiology, bench research or "first principles"	29 (44.6)
Could not be rated for level of evidence	Animal studies; cadaver studies; basic science studies; review articles; instructional course lectures; Continuing Medical Education courses; editorials; correspondence	Excluded 0.0%

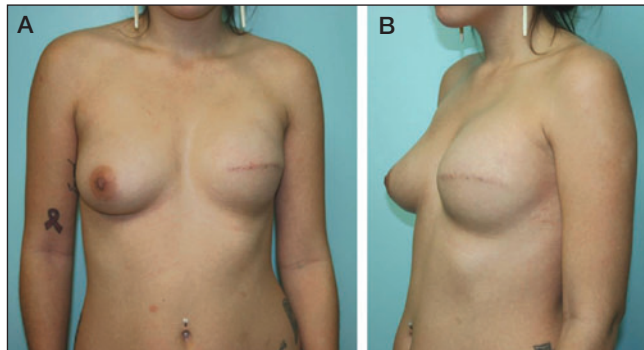


Figure 3) A and B Photographs six months following completion of breast reconstruction

LITERATURE REVIEW

A literature review was performed using the PubMed/Medline databases to identify all full-text, English-language studies involving device rupture of tissue expanders for all applications within the past 50 years from November 1, 2014. The following MeSH search terms were used: ["tissue expander" OR "tissue expansion"] AND ["rupture" OR "puncture" OR "failure"]. The search criteria resulted in 113 available articles. The results were narrowed further by including studies performed in humans with 65 articles available after excluding in vitro or animal studies (1-65). Data were then gathered from each article regarding level of evidence, etiologies of tissue expander rupture, location of tissue expansion and rates of overall complications including infection, capsular contracture, exposure or extrusions, device rupture, hematoma or seroma, skin necrosis, device failure not further specified or reconstructive failure not further specified. Details regarding contributing factors or comorbidities identified specifically in the study results or conclusions were also collected.

The majority of studies (83.1%) identified in the literature review were level IV or V evidence; only three high-quality, multicentre randomized controlled trials or systematic reviews were identified specifically. Studies that could not be rated for level of evidence, including animal studies, cadaveric studies, and review articles or editorials were excluded from further analysis (Table 1). The breast was the most common location for the use of tissue expansion (61.5%), followed by head and neck (8%), non-breast trunk (7%), lower extremity (6%) and burn-related (4%) regions (Table 2). The majority of the studies included in the literature review specifically report on complications related to tissue expansion (92.3%). Of the reported complications, infection was the most common reported complication (40.0%), followed by capsular contracture (18.5%), exposure or extrusion of the device (16.9%), device rupture (15.4%), reconstructive (15.4%) or device failure (10.7%) not otherwise specified, hematoma or seroma (6.2%), and skin necrosis (4.6%) (Table 3). The range of reported device rupture or not otherwise specified device failure varied significantly in the literature with a range of 0.0% to 1.6% (10 studies) and

0.0% to 6.0% (seven studies), respectively (Table 3). The literature was further assessed for contributing or confounding factors associated with an increased incidence of complications following tissue expansion, and history of previous radiation therapy was the most common contributing factor, followed by a history of smoking, previous chemotherapy, elevated body mass index and a history of overexpansion of the tissue expander device. In individual case reports, a myriad of potential causative or associated factors with device failure or rupture were identified, including a history of recent blunt or penetrating trauma, overexpansion of the device beyond manufacturer recommendations, capsular contracture, mammography or imaging studies, and iatrogenic rupture at the time of accessing the fill port. In the 10 studies that specifically report tissue expander device rupture as a complication, the location of tissue expansion was most commonly the breast (40%) followed by the head and neck (30%) and lower extremity (10%). In two of the three head and neck articles (2,3) that reported on device rupture of the tissue expander, the presence of bony exostosis or osteophyte formation was reported and implicated in the malfunction of the device. The present literature review did not identify any instances of rupture of a breast tissue expander related to the formation of bony exostosis or osteophytes.

DISCUSSION

The incidence of device failure or rupture during tissue expansion is rare, and the etiology of device rupture is most commonly idiopathic; however, a multitude of potential etiologies have been reported including direct trauma, device overexpansion beyond manufacturer recommendations, capsular contracture, compressive forces during medical imaging studies, iatrogenic device damage during operative placement of the device or iatrogenic rupture during the process of filling the device. Factors associated with the nature of the use of tissue expansion are a primary determinant of complications during tissue expansion, including location of tissue expansion and a history of medical comorbidities including smoking, chemotherapy, radiation therapy and elevated body mass index. Factors associated with the manufacturing of the device are also important, including the age of the device, surface properties of the device shell, the presence of an integrated versus remote injection port, the size of the injection port zone and the volume of the device.

Mentor and Allergan (USA) tissue expander manufacturer instructions recommend a preliminary device inspection at the time of tissue expander placement with an initial fill and subsequent manual compression to identify any defects or leaks in the device before placement. The manufacturer instructions further advise against filling of the device to volumes greater than the manufacturer recommendation.

The process of tissue expansion can have demonstrable effects on bone (66-68). In the head and neck, tissue expansion has been reported to be associated with the formation of bony exostosis surrounding the periprosthetic capsule with case reports of outer-table calvarial fracture and bony osteophyte formation following tissue expansion for scalp reconstruction. In breast and chest wall reconstruction, the presence of chest wall deformities, costochondral remodelling and rib fracture

TABLE 2
Location of reported tissue expansion in included studies

Body region	n (%)
Breast	40 (61.5)
Head and neck	8 (12.3)
Non-breast trunk	7 (10.8)
Lower extremity	6 (9.2)
Burn-related	4 (6.2)

have been reported, and are often attributed to hypertrophic inelastic capsule formation, submuscular tissue expander location, osteoporosis and a history of previous radiation therapy. Bony changes associated with tissue expansion are potentially reversible following completion of the expansion process (68).

Literature review for the terms “costal exostosis” or “chest wall exostosis” resulted in 135 publications indexed on Medline with multiple reports of sequelae ranging from incidentally noted idiopathic exostosis, nerve compression and thoracic outlet syndrome to potentially life-threatening complications, including pneumothorax, hemothorax, pericardial effusion and diaphragm rupture (69,70). The etiology of chest wall or costal exostosis is often not clear; however, injury to the rib periosteum or perichondrium, either traumatic or iatrogenic, has been implicated in the formation of secondary exostosis. Animal studies of tissue expansion in calvarial and long bones have demonstrated bony erosion underlying and bony deposition at the periphery of the tissue expander device. The histopathological correlation of these gross changes includes enhanced osteoclastic bone resorption beneath the tissue expander and a periosteal reaction at the periphery of the device with increased osteoblastic bone deposition. This phenomenon is a form of bony remodelling in response to pressure stimulation, and with removal of the pressure stimulus demonstrable changes in bone remodelling occurs (68).

Three articles (2,3,9) identified in our literature search attribute a tissue expander device rupture to a specific etiology, all three of which involve head and neck reconstruction; specifically, scalp tissue expansion. Two of the three attribute the device rupture to exostosis located at the periphery of the tissue expander, and one involved a fracture of the outer table of the calvarium with rupture of the device attributed to a bony fracture fragment. In these three publications, the authors cite three potential contributing factors to the formation of bony osteophyte formation: the length of time required for head and neck tissue expansion; tractional forces placed on the calvarial periosteum due to large volume tissue expansion; and over-expansion of the tissue expander device beyond the manufacturer's suggested maximal volume. Hallock (71) performed an ex vivo study to define the maximum volume of tissue expander device failure related to over-expansion and identified that over-expansion is, in general, safe without risk of expander device failure at at least 15 times (and up to 157 times) the manufacturer's suggested maximum fill volume. Hallock (30) later established the clinical safety and efficacy of over-expansion of tissue expander devices and noted a significantly decreased risk of

TABLE 3
Complications reported tissue expansion in included studies

	n (%)
Studies reporting complications	60 (92.3)
Reported complications	
Infection	26 (40.0)
Capsular contracture	12 (18.5)
Exposure/extrusion	11 (16.9)
Rupture	10 (15.4)
Reconstructive failure not otherwise specified	10 (15.4)
Hematoma/seroma	4 (6.2)
Skin necrosis	3 (4.6)
Comorbidities/contributing factors	
History of radiation therapy	14 (21.5)
Smoking	6 (9.2)
History of chemotherapy	5 (7.7)
Body mass index	3 (4.6)
Overexpansion	2 (3.1)

complications in over-expanded devices in breast reconstruction, a fact that the author attributed to an inability to achieve over-expansion of the device following a complication. However, these studies do not specifically assess the safety of device overexpansion in the setting of bony exostosis, and one would expect a higher degree of device rupture in the setting of a mechanically strained expander envelope opposed to an irregular bony surface. No instances of device rupture associated with bony exostosis were noted outside of the head and neck and, specifically, no reports of tissue expander rupture attributed to chest wall or osteochondral bone formation were reported in breast reconstruction.

In our case, the location of the chest wall exostosis was identified in the medial-inferior costochondral junction in the region in which the pectoralis muscle insertion was elevated off of the chest wall during initial tissue expander placement. The tissue expander device in our patient was over-expanded by 145 mL; however, it is common in our practice to over-expand devices in the setting of breast reconstruction up to twofold above manufacturer's suggested maximal fill volumes to achieve optimal volumes in patients with narrow base widths without an increase in overall rates. Our patient was young and physically active, and an avid hunter. The patient had been hunting three days before noting deflation of the device, and questioned whether the rifle recoil could have contributed to her device rupture. Fortunately, in this instance, the patient had completed her tissue expansion and we were able to replace her ruptured device with a permanent silicone implant.

In general, the rate of overall device failure and tissue expander device rupture are low in the reported literature, with rates of 0.0% to 6.0% and 0.0% to 1.6%, respectively; however, the present article demonstrates the importance of evaluating the tissue quality of the peri-prosthetic capsule and pocket following a device failure to ensure that chest wall exostosis, a potential cause of further device failure, is not present.

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