Implant-Based Breast Reconstruction in Patients with Connective Tissue Disease: A Case Report Demonstrating Safety and Efficacy in Marfan Syndrome

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Plastic surgeons performing prosthetic breast reconstruction face a demanding task in manipulating and reconstructing the altered soft tissue envelope in patients with connective tissue disease (CTD). Despite the difficulties inherent to this unique patient population, there are no reports in the literature describing breast reconstruction or tissue expansion in patients with CTD. We therefore aim to provide a general guide for those who face this clinical challenge using a representative case of breast reconstruction with tissue expansion in a patient with Marfan syndrome.

Marfan syndrome is a variably penetrant, autosomal dominant disorder caused by mutations in the FBN1 gene, which encodes fibrillin-1.1 Fibrillin is a large glycoprotein component of the extracellular matrix (ECM). Polymers of fibrillin form microfibrils and microfibrils, when combined with elastin, form elastic fibers.1 Given the ubiquitous nature of these ECM components, Marfan syndrome affects many organ systems including the cardiovascular and pulmonary systems, eye, skeleton, and skin.1,2 Manifestations of the disease include aortic aneurysm formation, spontaneous pneumothorax, and lens dislocation.5 Moreover, the role of elastin and elastin turnover in the development and progression of cancer is a current area of active investigation.3,4

Diagnosis of Marfan syndrome is made using the Ghent nosology that was established in 1996 and has recently been updated in 2010.5 Factors included in the 2010 Ghent nosology include: presence of family history of Marfan syndrome, presence of the FBN-1 genetic mutation, presence of ectopia lentis, aortic root Z-score, and a systemic score comprised of presence of various physical findings such as scoliosis, striae, myopia, or mitral valve prolapse, among others.5 The original nosology determined the Marfan syndrome “was present if two major organ systems were involved and if a third organ system was involved in a minor way.”5 The updated nosology considers alternative diagnoses that could be made in a patient being evaluated for Marfan syndrome. These related entities include Loeys–Dietz syndrome (LDS), familial thoracic aortic aneurysm and/or dissection (FTAAD), familial mitral valve prolapse syndrome (MVPS), mitral valve, aorta, skeleton, and skin (MASS) phenotype, and Ehlers-Danlos syndrome (EDS). This updated criteria has increased the diagnostic yield of the Ghent nosology for Marfan syndrome, notably for patients presenting with thoracic aortic dilatation.5

In the context of breast reconstruction, the skin and skeletal manifestations of Marfan syndrome are most pertinent. The skeletal system is affected by overgrowth of tubular long bones, including the ribs; scoliosis may also be present in Marfan syndrome.6 This overgrowth often leads to pectus excavatum or carinatum deformities of the chest.1,2 At the epidermal-dermal junction, microfibrils likely play a role in the adhesion of skin layers.1 Skin manifestations of the disease include prominent striae atrophicae in unusual areas, suggesting an impaired response to stretch or tension.2,4,7,8 Abnormalities in the ECM provides a unique challenge in prosthetic breast reconstruction in patients with Marfan syndrome and all CTDs. Skeletal deformities provide a contorted foundation upon which to base reconstruction while...
the soft tissue envelope is impaired in its ability to respond and adapt to tissue expansion potentially leading to the pathologic production of striae atrophicae. We provide the first description and guide in the literature to facilitate tissue expansion and prosthetic breast reconstruction in patients with CTD.

**CASE PRESENTATION**

The patient is a 39-year-old woman with a past medical history of Marfan syndrome, pectus excavatum ascending aortic aneurysm status post graft reconstruction, mitral valve prolapse, and melanoma. The patient had pectus repair thirty-three years ago with a custom implant, but this had to be removed due to infection. In addition to the central sternal depression, the patient had a significant chest wall asymmetry with the right anterior chest wall retraction compared with the left side. On physical examination, the patient had grade I ptosis of the left breast and glandular ptosis of the right breast (Figure 1A,B). A screening mammography revealed multiple subareolar microcalcifications in the left breast found to be ductal carcinoma in situ (DCIS) on open biopsy. She elected to undergo bilateral skin-sparing mastectomy (SSM) with two-stage prosthetic reconstruction. Of note, a BRCA test performed preoperatively was negative. The test was performed for the purpose of genetic counseling for her daughters and was not the deciding factor for the patient’s clinical course.

The SSM was accomplished through elliptical incisions around the nipple-areola complex (NAC) by sharp dissection with breast scissors (Figure 1C). A sentinel lymph node biopsy on the left was negative. Both the right and left mastectomy specimens weighed approximately 200 grams. The pectoralis muscles ended high above the inframammary fold and were insufficient to provide coverage for the tissue expanders (TE). A layer of ready-to-use AlloDerm (LifeCell Corporation, Branchburg, NJ) was therefore employed as an inferi-or-sling bilaterally. The pectoralis muscles were released to 3 o’clock on the right and 9 o’clock on the left side. The acellular dermal matrix (ADM) slings were also used to provide a barrier for the TE s from migrating medially, especially given the pectus excavatum deformity. Each TE was intra-operatively filled to 200 milliliters of a total capacity of 250 milliliters.

The TEs were expanded by differing amounts to equalize the anterior projection over a 12-week period. The drains were placed for 15 days. Over the course of four fillings, the right and left TEs were expanded to a total of 410 and 350 milliliters, respectively. The right TE was overfilled to compensate for the posterior positioning of the chest wall. No single TE filling was greater than 60 milliliters per breast. After expansion, she underwent expander removal, capsulotomy, and implant insertion. After several extensive discussions with the patient, Allergan style 410-FF implants were chosen. The surgeon felt that the textured form-stable implant would provide better stability on the chest wall in the long-term. Additional capsulorraphy was performed medially to separate the breast mounds. A 425-milliliter and 375-milliliter Allergan style 410-FF implants were inserted on the right and left side, respectively (Figure 1D,E). After a follow-up period of 8.5 months, the patient has gone on to heal uneventfully and has returned to work full time without any complications.

**DISCUSSION**

Connective tissue disease, such as Marfan syndrome, presents a unique challenge for plastic surgeons performing prosthetic breast reconstruction. Alterations in the ECM impede the skin’s ability to withstand stretch and, inherently, tissue expansion. Frequent concomitant skeletal overgrowth leads to sternal defects that further complicate successful breast reconstruction.

Of note, pre-operative risk stratification and clearance of patients with Marfan syndrome should be individualized given their unique cardiac manifestations. This patient had a cardiac history of thoracic aortic aneurysm repair in the distant past and mitral valve prolapse without clinical findings; therefore, she underwent clearance by the anesthesiologists without specific cardiology clearance. However, the surgeon should have a low threshold to refer patients with Marfan syndrome for clearance by a cardiologist with an unclear history of cardiac manifestations or any sign of cardiac instability, such as dyspnea on exertion or new onset lower extremity edema.

Chest wall and sternal deformity in patients with Marfan syndrome may be due to a combination pectus excavatum as well as scoliosis.9 In patients with CTD and sternal deformity, the plastic surgeon must begin by carefully assessing the pectoralis muscle configuration. The deformities encountered in CTD are heterogeneous and maybe combined with anomalous pectoralis insertions.9 We find that, due to the chest wall deformity, the pectoralis muscle even with the serratus muscles may be insufficient for prosthesis coverage, necessitating ADM use. ADM also provides an additional barrier layer from the implants to migrate centrally creating synmastia.

After the pectoralis muscles are raised and abnormal insertions released, the pocket must be designed to provide an aesthetic breast mound despite a contorted skeletal base upon which the expander, and ultimately implant, will rest. Although the incidence of pneumothorax in breast reconstruction is low,10 this risk is theoretically raised in the presence of chest wall deformity.7 Additional risk is present in cases in which chest wall repair has been attempted prior to breast reconstruction as in the presented case. One report documents chest wall resection and pleural damage in such a case resulting in pleural effusion requiring thoracentesis.11
Figure 1. Preoperative antero-posterior (A) and lateral (B) views of this 39-year-old woman with Marfan syndrome presenting prior to bilateral mastectomy and implant-based reconstruction. The photograph demonstrates significant chest wall deformity and breast asymmetry. Preoperative on-table view (C) of the patient with markings for skin-sparing mastectomy (SSM) through elliptical incisions surrounding the NAC. The mass is located approximately 1.8 cm below the level of the nipple-areola complex (NAC) in the 7 o’clock position, explaining the lower planned incision on the right side. A prior sternotomy scar and abdominal striae atrophicae are noted. Postoperative antero-posterior (D) and lateral (E) results 3 months after the form stable implant placement. The breast mounds are similarly projected and there is no evidence of increased striae, synmastia, or bony recession.
There is one report of breast reconstruction in idiopathic pectus excavatum deformity with both autologous tissue and customized prosthetic implants. However, unlike the representative case, this report involved a delayed reconstruction without tissue expansion. Using non-customized implants, one case series details breast augmentation in patients with pectus excavatum. The authors recommend detaching anomalous pectoralis insertions and minimizing lateral dissection to mask medial sternal deformities. Textured silicone implants were used.

The plastic surgeon must next manage an altered ECM in CTD such as Marfan syndrome. With no reports in the literature of tissue expansion in patients with ECM, it was previously unknown how this altered ECM would respond to expansion. Given these patients’ propensity for forming striae atrophicae, there is a concern that tissue expansion, by imparting stretch on the tissues, may produce additional striae. Our experience demonstrates that tissue expansion may safely be performed in breast reconstruction in patients with CTD, specifically Marfan syndrome, without production of additional striae atrophicae. Subsequent expansions should be sequentially planned and may require differential amounts of expansion in bilateral reconstruction when a significant chest wall asymmetry exists. The overall objective is to minimize large changes in tension placed on an abnormal ECM that may lead to striae formation. As such, tissue expansion should proceed carefully in this patient with no single expander filling exceeding 60 milliliters per breast. Textured implants may then be used to minimize rotation or migration after definitive placement. Additional capsulorraphy at the time of exchange is recommended to further separate the breast mounds if synmastia is an issue during the expansion process.

CONCLUSIONS

We present the first guide to our knowledge describing breast reconstruction and tissue expansion in a patient with connective tissue disease, specifically Marfan syndrome. In Marfan syndrome, altered skeletal growth and ECM lead to sternal deformities and abnormal striae atrophicae, respectively. We recommend careful assessment of pectoralis muscle configuration, individualized pocket creation in consideration of sternal and anterior chest wall deformities, and avoiding extreme tension during tissue expansion. The second stage surgery can be used to optimize the cosmetic result including utilizing capsulorraphy, different implant sizes, and textured form-stable implants.

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