The Use of TIGR Matrix in Breast Aesthetic and Reconstructive Surgery

Is a Resorbable Synthetic Mesh a Viable Alternative to Acellular Dermal Matrices?

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KEYWORDS

• Synthetic mesh • TIGR matrix • Resorbable mesh • ADM alternative • Reconstruction with mesh • Mesh in aesthetic breast

KEY POINTS

- Synthetic mesh is a viable alternative to acellular dermal matrices when used in breast surgery.
- The use of 100% resorbable synthetic mesh in implant-based breast reconstruction significantly lowers the reconstruction cost while maintaining the benefits of tissue enforcement in the lower pole.
- The use of 100% resorbable synthetic mesh in aesthetic surgery might potentially help maintain long-lasting aesthetic results.
- TIGR Matrix exhibits promising preliminary results when used in breast surgery, such as low seroma and infection rates, when compared with other nonresorbable or semiresorbable synthetic meshes.

INTRODUCTION

The use of acellular dermal matrices (ADM) and synthetic meshes in breast surgery is gaining popularity in recent years. In implant-based breast reconstruction, complete implant coverage has been the main target of surgeons in order to reduce the risk of implant exposure. The matrices are widely used in order to facilitate the complete coverage of the prosthesis. In aesthetic breast surgery, ADMs and synthetic meshes can be used as a sling to decrease gravitational changes as well as to strengthen weakened inferior pole tissue, so cosmetic benefits such as stable nipple-areola position and adequate breast projection can be achieved. The use of these matrices and meshes in both reconstructive and aesthetic breast surgery is promising, especially because the surgical techniques can be used by almost every experienced surgeon and are characterized with a steep but fast learning curve.

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Many options are currently available on the market and vary from human cadaveric ADM to fetal bovine–derived ADM, bovine-derived collagen matrix, porcine-derived ADM, and synthetic meshes. ADMs are produced by decellularization of dermal matrix, a process that leaves the extracellular scaffold intact. It is within this scaffold that patient's cells repopulate and therefore vascularize the graft. Synthetic meshes are defined as products that are manufactured synthetically. They can be either nonresorbable, partially resorbable, or completely resorbable devices. Concerns regarding the significant cost associated with the biological matrices have been expressed, especially when compared with the synthetic meshes.

It is well documented in the literature that synthetic meshes are viable alternatives to ADMs.[1–3] This article documents the authors' experience in the use of a synthetic 100% bioresorbable surgical mesh (TIGR Matrix, Novus Scientific, Uppsala, Sweden) in breast reconstruction as well as in breast aesthetic surgery.

METHODS

The authors performed a retrospective review of patients who underwent implant-based breast reconstruction as well as patients who underwent breast reduction mammoplasty procedures with the use of the TIGR Matrix Surgical Mesh.

Forty-nine consecutive patients, who were operated between 2014 and 2016, were included in the study. There were no exclusion criteria. Complications and surgical revision rate data were collected and documented. Retrospective review approval was obtained by the ethical board of the hospital.

All patients received perioperative care from the senior author and members of his team at Sandro Pertini Hospital. They received prophylactic antibiotic on anesthesia induction, followed by mastectomy for breast reconstruction patients performed by the general surgeon. Subsequently, tissue expander (TE) with mesh or direct to implant (DTI) with mesh breast reconstruction was performed immediately after mastectomy. Polyurethane foam–covered implants (Polytech, Dieburg, Germany) were used in DTI reconstruction, and textured tissue expanders (Mentor, Allergan, Silimed) were used for the first stage of the 2-stage reconstruction.

The implant or tissue expander pocket was prepared by elevation of the pectoralis major muscle superiorly, and TIGR mesh was sutured to the muscle's lower border inferiorly. The mesh was subsequently sutured to the chest wall at the desired level of the newly created inframammary fold (IMF; **Fig. 1**). The pocket and the implant or TE were irrigated with cefazolin solution, and the surgical team routinely changed their gloves before implant placement. Complete implant coverage was therefore achieved by pectoralis muscle superomedial and the mesh inferolateral. In order to maximize the contact surface between the implant and the pocket walls, suction drains were placed in every patient (one subcutaneously and one in the pocket). The TE was filled intraoperatively according to the volume capacity of the pocket.

Reduction mastopexy operations were performed under general anesthesia. Inferior pedicle technique was performed as first described by Ribeiro and colleagues.[4,5] TIGR matrix was used to stabilize the flap and to secure it on the pectoral fascia (**Fig. 2**).

All patients received intravenous antibiotics for the first postoperative day, and drains were removed when fluid collection was less than 30 mL/d. The first follow-up visit was routinely at the second postoperative week and thereafter at 1, 3, 6, and 12 months. For the 2-staged

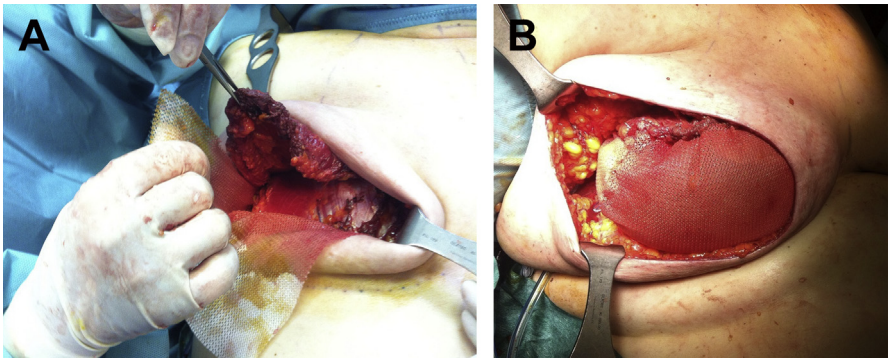

Fig. 1. Implant-based breast reconstruction using TIGR Matrix: (*A*) securing the mesh on the IMF, (*B*) implant pocket created by pectoralis major and mesh.

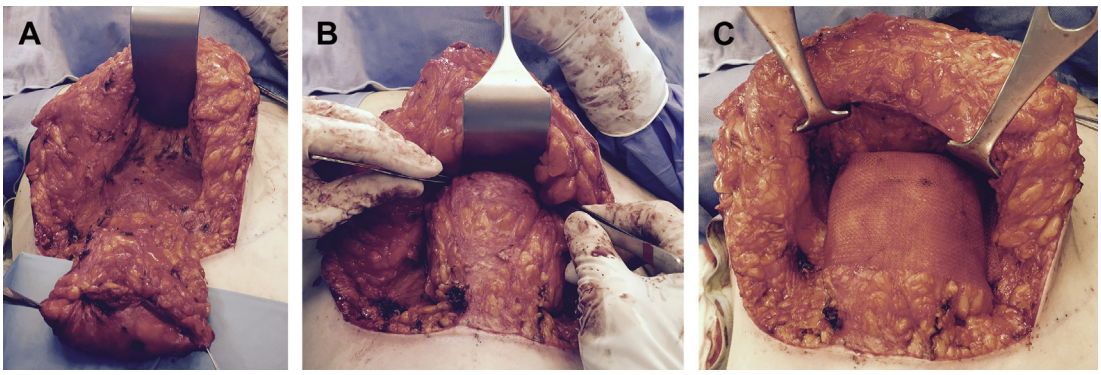

Fig. 2. (*A–C*) Reduction mammoplasty using TIGR Matrix for securing the Ribeiro flap on the pectoralis major fascia in order to improve the upper pole definition.

reconstruction procedures, the TEs were filled every week by adding 10% of the total TE volume capacity or as tolerated by the patient.

All the statistical analyses were performed with Stata 13 statistical software (StataCorp LP, College Station, TX, USA). Descriptive statistics were reported as mean and percentages. Associations between categorical variables were evaluated by the use of the χ^2 test, and the P value <.05 was considered statistically significant. Mesh-complication rate was estimated by means of the Kaplan-Meier method for cumulative incidence. Time of complication onset was defined as the time from the initial breast surgery to the diagnosis of the mesh complication (in months). Patients who did not experience mesh complications were reviewed after the final follow-up session.

RESULTS

Forty-nine patients underwent breast surgery with the use of the TIGR Matrix mesh. The mean patient age was 51 years (range, 25–73 years), and the mean follow-up period was 12 months (range 0–43 months) shown in **Table 1**. There was no patient lost to follow-up.

Table 1
Patient characteristics

No. of Patients	49
Mean age, y (range)	51 (25–73)
Body mass index > 30	8 (16.3%)
Smokers	7 (14.3%)
Diabetes	1 (2%)
Bilateral	11 (22.4%)
Radiotherapy	5 (10.2%)
Chemotherapy	22 (44.9%)
Neoadjuvant chemotherapy	6 (12.2%)

Eleven patients underwent bilateral interventions, whereas the remaining 38 patients were unilateral. Therefore, a total of 60 meshes were used in 60 breast surgeries (54 breast reconstructions and 2 mastopexies and 4 breast reductions). Twenty-three patients had a history of chemotherapy; 7 patients had a history of neoadjuvant chemotherapy, and 5 patients received radiation therapy.

One device was lost because of prosthesis removal due to skin necrosis.

For 54 breast reconstructions performed using mesh (52 for cancer and 2 for fibroadenoma removal) (**Table 2**), 35 were after skin-sparing mastectomy, 13 were after nipple-sparing mastectomy, and 4 were after skin-reducing mastectomy. Two meshes were used to treat contour deformities in secondary reconstruction attempts.

The overall mesh complication rate is shown in **Table 3**. Capsular contracture was observed in one reconstructed breast (1.7%). Three reconstructed breasts exhibited incision dehiscence (5.0%), 4 breasts exhibited postoperative hematoma (6.7%), and in 3 breasts, skin necrosis was observed (5.0%). Infection was reported in one reconstructed breast (1.7%), whereas seroma was observed in 2 (3.3%).

Among the overall complications, those most likely related to the use of the mesh are assumed to be seromas and infections. Therefore, these complications in this context are defined as “mesh complications.” The cumulative incidence of mesh complications was 5.4%. From a total of 60 meshes used, 2 seromas and 1 infection were observed.

No statistically significant differences were observed in complications occurring for patients who underwent neoadjuvant chemotherapy (P = .296) or diabetic patients (P = .817) or even for patients who were smokers (P = .817).

Table 2
Reason for surgery with the use of the device by type of intervention (results are shown per device)

	Nipple-Sparing Mastectomy	Skin-Sparing Mastectomy	Skin-Reducing Mastectomy	Secondary Reconstruction	Reduction Mammaplasty	Total
Cancer	11	4	35	2[a]	—	52
Fibroadenoma	2	0	0	0	—	2
Weight loss	—	—	—	—	2	2
Breast ptosis	—	—	—	—	4	4
Total	—	—	—	—	—	60

[a] Mesh device was used to treat contour deformities in previously reconstructed breasts.

Conversely, a statistically significant association (P = .01) between mesh complications and obesity was observed: devices used in obese patients are more likely to present complications compared with devices used in nonobese women (22% vs 2%) (see **Table 3**).

DISCUSSION

Even though implant-based breast reconstruction with TE or DTI is widely used, it has disadvantages, such as high-riding implant due to muscle stiffness and restricted expansion of the inferior pole. The aesthetic results can be further compromised by minimal or no definition of the IMF, despite the skin availability that skin-sparing or nipple-sparing mastectomies usually provides.

In aesthetic breast surgery, especially in reduction mammoplasty, bottoming out is a common concern of the surgeon. It is widely experienced that in patients with poor skin quality, gravity and aging will eventually act against a previously good aesthetic result by "slipping" of the parenchyma below the IMF disproportionately with the nipple-areola complex (NAC).[6] Therefore, NAC position is compromised, breast projection is diminished, and a long and ptotic inferior pole is already established.

Matrices such as ADM emerged on the market in order to minimize such complications in both breast reconstruction[7] and breast aesthetic surgeries.[8] There are plenty of studies in the literature explaining the pros and cons of the ADM,[9,10] but minimal data are available regarding the long-term resorbable synthetic mesh.

TIGR Matrix is a long-term 100% bioresorbable synthetic mesh product introduced in 2010. The mesh consists of 2 fibers. The fibers have different degradation times and both resorb completely in the end. The strength is high in the beginning and decreases by time to promote a good wound healing. Its 2 different synthetic fibers provide high strength for more than 6 months and are completely resorbed 3 years after implantation.[11] Synthetic meshes have been used in many surgical specialties for many years. Even though data on TIGR Matrix are available in the literature predominantly for hernia surgery, it is also used for breast reconstruction in Europe (**Figs. 3** and **4**),

Table 3
Mesh-complications by risk conditions

		Mesh Complications				
		Yes		No		
		No.	%	No.	%	*P* Value
Neoadjuvant chemotherapy	Yes	1	12.5	7	3.9	.296
	No	2	87.5	50	96.2	
Obesity	Yes	2	22.2	7	77.8	.01
	No	1	2.0	50	98.0	
Diabetes	Yes	0	0.0	1	100.0	.817
	No	3	5.1	56	94.9	
Cigarette smokers	Yes	0	0.0	7	100.0	.518
	No	3	5.7	50	94.3	

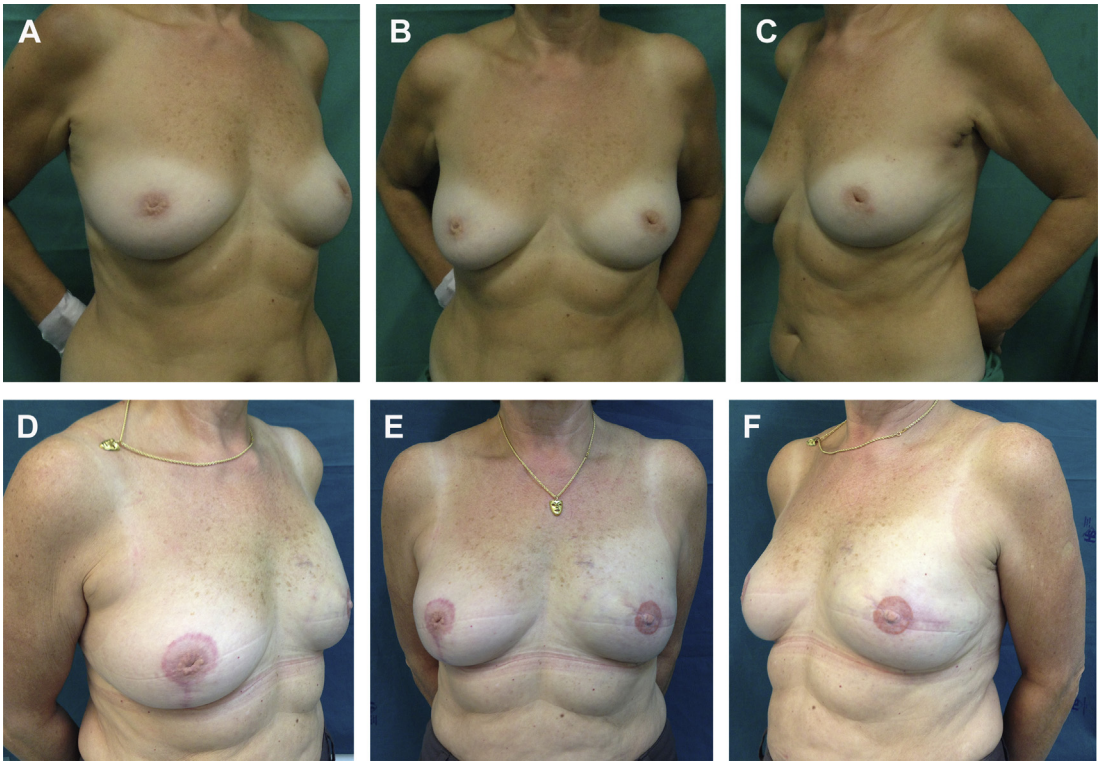

Fig. 3. DTI reconstruction after skin-sparing mastectomy, using polyurethane-coated anatomic implant (395 mL) and TIGR Matrix and contralateral mastopexy: (*A–C*) preoperative, (*D–F*) postoperative.

and the information can be considered interchangeable. Its biocompatibility is also shown in vivo with the formation of blood vessels and the well-structured collagen fibers.[11]

In the authors' preliminary findings, only one of the breasts with mesh complications required reoperation. In 2 breasts with seroma complication, each exhibited fluid collection that lasted more than 1 month postoperatively, but symptoms eventually resolved without any surgical intervention. The patient with infection was treated with TE and mesh removal and intravenous antibiotics. The authors recorded yet another TIGR Matrix explantation in a patient who experienced skin necrosis. However, this type of complication was assumed not to be related to the device, but rather to be related to the mastectomy flap quality and viability.

The total postoperative complication rate for meshes requiring revision surgery was 11.6% (**Table 4**), but only in 3.3% was TIGR Matrix removal indicated. This rate is similar to previous studies published in the literature[1] regarding this mesh. The cumulative mesh-complication rate was calculated by Kaplan-Meier survival analysis (**Fig. 5**). It showed that all the mesh complications occurred within the first 3 postoperative months.

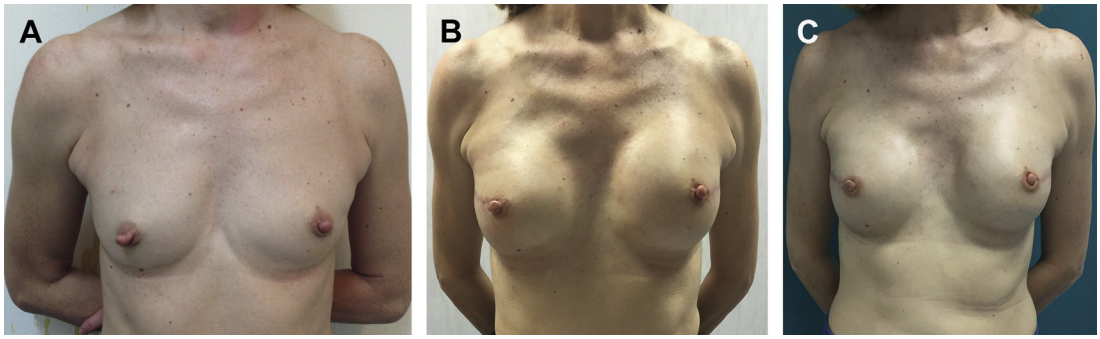

Fig. 4. Bilateral 2-stage breast reconstruction with TIGR Matrix after NAC-sparing mastectomy: (*A*) preoperative, (*B*) postoperative after stage 1, (*C*) postoperative after stage 2.

Table 4
Implant revision by complication

Complications	No Surgical Intervention No. (%)	Surgical Revision No. (%)	Total No. (%)
Capsular contracture	0	1 (1.7)	1 (1.7)
Dehiscence	0	3 (5.0)	3 (5.0)
Hematoma	4 (6.7)	0	4 (6.7)
Infection	0	1 (1.7)[a]	1 (1.7)
Skin necrosis	1 (1.7)	1 (1.7)[a] + 1 (1.7)	3 (5.0)
Seroma	2 (3.3)	0	2 (3.3)
Total	7 (11.6)	7 (11.6)	14 (23.3)

[a] Surgical revisions that resulted in breast implant removal and mesh device explantation.

Several retrospective studies regarding the use of ADMs in breast reconstruction are available in the literature. In a comprehensive analysis of the literature, Scheflan and Colwell[9] summarized the complication rates with ADM-assisted implant-based breast reconstruction in controlled studies.[12–30] They reported that except for Vardanian and colleagues,[19] infection rates ranged from 3.0% to 28.9%. Moreover, seroma incidence rate range fluctuated from 1.5% to 29.9%. In the authors' retrospective study, they found infection incidence rate of 1.6% and seroma incidence rate of 3.6%, rates that are similar to other studies on TIGR Matrix in the literature.[1] However, because of the limitations that any retrospective study has, the authors highlight the need of a controlled study for TIGR Matrix use in breast reconstruction and aesthetic surgery.

The range of mesh complications (infection and seroma) as reported in the literature ranges from 3.4%, documented by Vardanian and colleagues,[19] to 44.3%, reported by Lanier and colleagues.[23] Most of the studies documented more than 10% rate of mesh complications,[16–18,20–24,27,28] a rate significantly higher than the authors' preliminary findings of 5.4%.

In addition to the aforementioned indications, ADM use is also described for stabilizing implant pocket, to fill contour defects caused by capsulectomy, to repair symmastia, or even to treat rippling effects.[29,30] However, ADM undoubtedly is an expensive product[31] to be added to the total cost of breast surgery, whether it is for reconstructive or aesthetic purposes. In the authors' experience, TIGR Matrix was successfully used to treat various complications resulting from volume defects and also improving contour deformities and

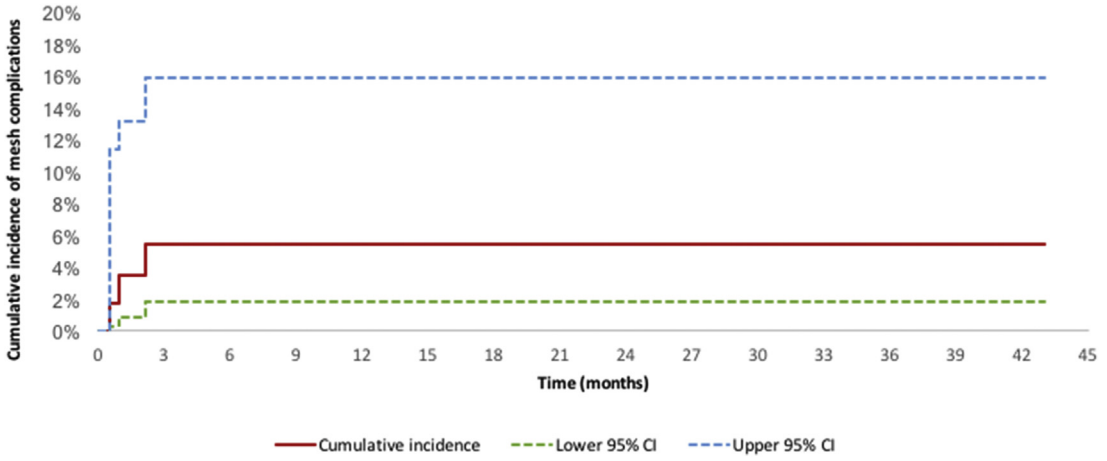

Fig. 5. Kaplan-Meier survival analysis for mesh complications and 95% confidence interval (CI).

rippling effects. Moreover, it was used in nipple reconstruction as tissue reinforcing "roll" to ensure the long-term nipple projection.

Even though TIGR Matrix is a synthetic mesh, when compared with other synthetic but nonresorbable meshes, it not only shows potentially lower seroma and infection rates but also most importantly a lower rate of revisional and mesh explantation surgeries.

In a large retrospective study of 231 procedures using Titanium-coated Polypropylene mesh (TiLOOP Bra; pfm medical, Cologne, Germany), a nonresorbable mesh, overall seroma and infection rates of 4.8% and 6.1%, respectively, were reported.[2] The same study revealed mesh explantation and revisional surgery as high as 7.8% and 13.4%, respectively. More specifically, they documented 3.4% incidence of mesh complications requiring reoperation.

A more recent study of 70 immediate breast reconstructions using another nonresorbable mesh (Surgimesh-PET, Aspide Medical, La Talaudière, France)[32] revealed significantly higher mesh complication rates (seroma 8.6% and infection 10%).

In this preliminary documentation of the authors' experience in the use of TIGR Matrix, this mesh successfully provided the soft tissue support that was required in either breast reconstruction or breast aesthetic surgeries (**Fig. 6**). It is undoubtedly a less-expensive device (in some countries even 3–4 times less expensive than the ADMs available), a significant advantage especially in bilateral interventions. Moreover, TIGR Matrix

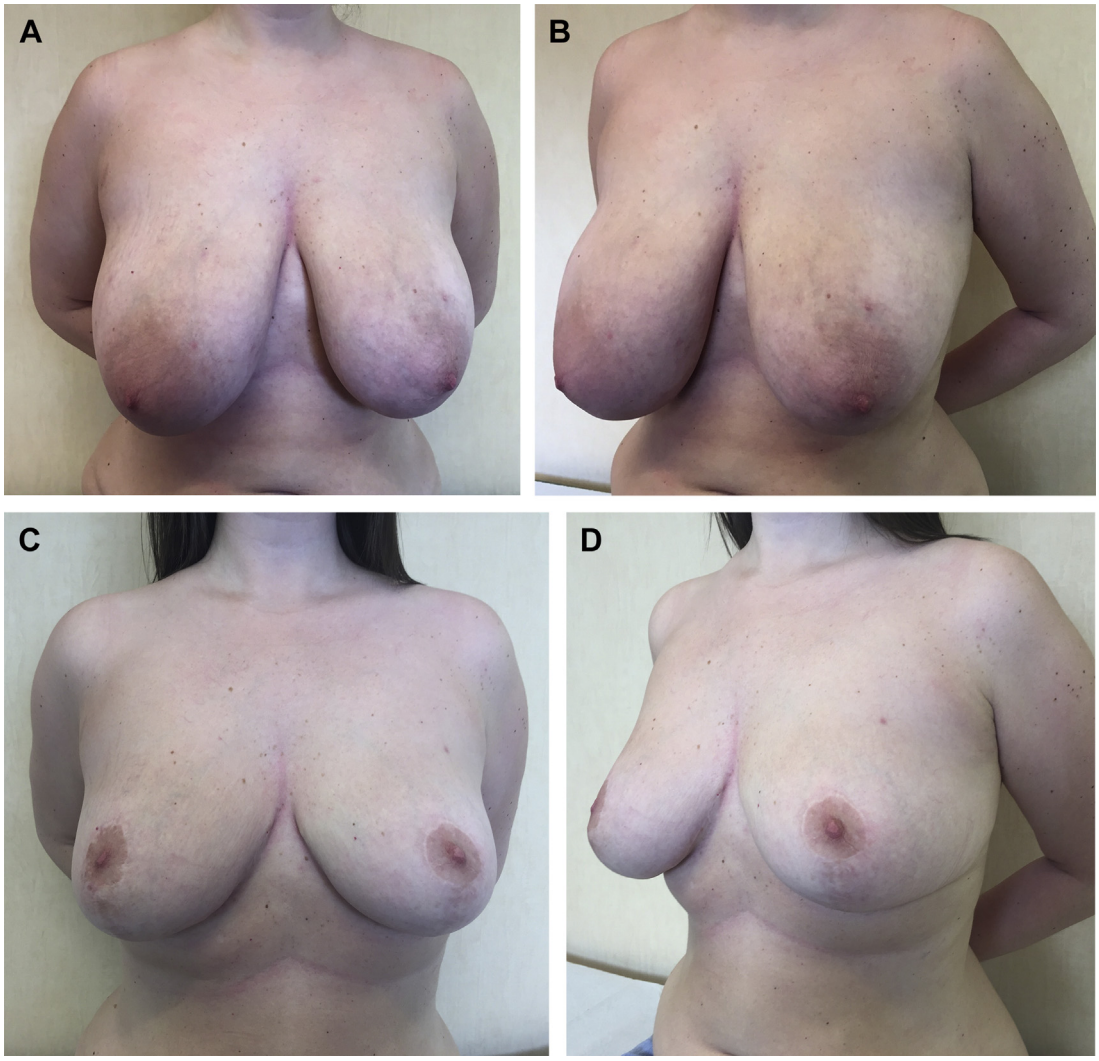

Fig. 6. Reduction mammoplasty using TIGR Matrix for securing the Ribeiro flap: (*A*, *B*) preoperative, (*C*, *D*) 1-year postoperative.

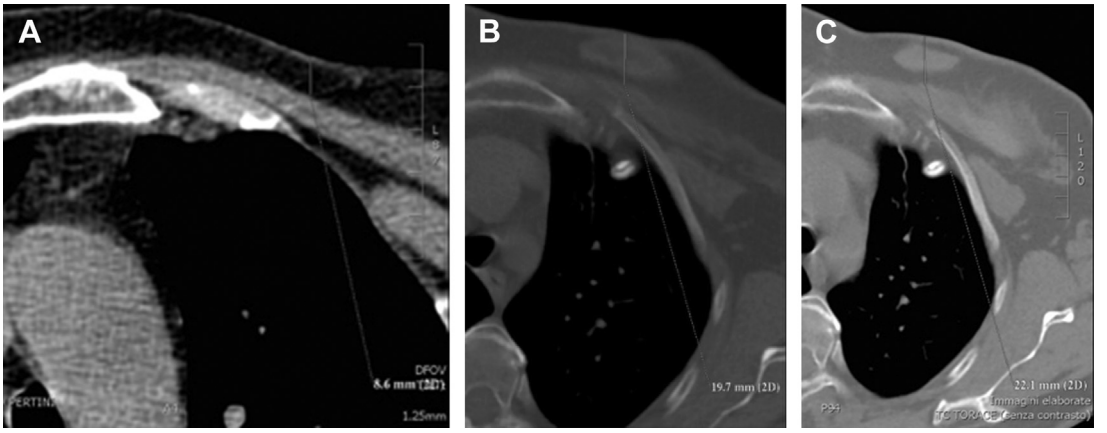

Fig. 7. (*A*) Preoperative computed tomographic scan to visualize soft tissue thickness measuring from the skin to the surface of the pectoralis major muscle. (*B*, *C*) The same patient on the third and 10th postoperative months, respectively.

appears to have long-term tissue reinforcement potential, but a longer follow-up with quantitative results is required to establish whether the volume benefit lasts longer than 3 years (**Fig. 7**). Another study of 116 one-stage breast reconstructions using a resorbable synthetic mesh (Vicryl; Ethicon Inc, Somerville, NJ, USA) documented infection incidence rate of 2.7%.[33] However, because this mesh is rapidly resorbed, no long-lasting tissue reinforcing benefits are expected.

SUMMARY

TIGR Matrix is an important tool in breast reconstructive surgery as well as in breast aesthetic surgery. The double properties of this mesh, short-term strength and long-term tissue reinforcement, as well as low cost renders this mesh a valuable device for achieving superior results in breast surgery. Moreover, it appears safe, because it is associated with low mesh-complication incidence and explantation rates.

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