

Mastopexy with 3D Preshaped Mesh for Long-Term Results: Development of the Internal Bra System

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Abstract

Background Numerous techniques for mastopexy and breast reduction have been described, indicating the absence of a generally accepted method that fulfills the essential criteria for obtaining a pleasing, long-lasting result. All techniques using local tissue for reinforcement will eventually face recurrent ptosis because essentially the physical tissue properties are not altered. To overcome this, synthetic mesh has successfully been used to obtain permanent results. This method, however, was not generally accepted because of the fear of complications and of reduced oncologic survey and because no practical system was in place. Meanwhile, research showed that mesh could be safely introduced into the female breast.

Methods An easy-to-use mesh implant was developed. It comes as a system consisting of three-dimensional, pre-shaped, feather-soft woven mesh in different sizes, and concomitant sizers to facilitate the insertion. It acts as an internal bra and is therefore named “the Internal Bra System.” The mesh replaces the attenuated natural suspensory system of the breast, returning what was lost by nature. Indications are breast ptosis, breast hypertrophy with ptosis, and contralateral correction after reconstruction.

Results A total of 170 patients (327 breasts) were treated with the longest follow-up of 4.5 years. No serious complications were encountered. Physical and X-ray examinations were still possible. No recurrent ptosis was observed and no scar hypertrophy.

Conclusion The Internal Bra System seems to have finally become the versatile way to obtain a predictable, pleasing, long-term result in mastopexy and breast reduction.

Keywords Mastopexy · Mesh · Polyester · Internal bra

The authors have no financial interest or commercial association with any of the mesh manufacturers. However, they have an interest in the Breform company that developed the intellectual property.

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Mastopexy aims to counteract the adverse effects of gravity and decrease in skin elasticity and firmness of the female breast with time, resulting in progressive ptosis. Numerous techniques have been described to find the right balance between the resulting scars and a lasting and pleasing new shape. Mastopexy, however, is generally thought to have only a temporary result and not a permanent outcome [1–7]. “Recurrent ptosis after mammoplasty can occur regardless of the techniques used” [8].

Almost all techniques rely on either skin reduction alone, skin reduction and repositioning of the glandular tissue, or repositioning in combination with any form of reinforcement including suspension sutures, dermal bra procedures, free dermis strips, dermoglandular pedicles, dermoglandular plication, fascia lata insertion, subdermal flaps, parenchymal flaps, de-epithelialized dermis strips, pectoral fascia suspension, lateral dermis suspension, superficial fascial system suspension, and muscular slings [1, 4, 6, 7, 9–35]. The reinforcements were designed to obtain a longer-lasting shape and to prevent recurrent ptosis. All these techniques, however, rely on the use of

local tissue, the same tissue that previously sagged, which it eventually will do again.

As summarized by Grotting and Chen [3]: “We still struggle to obtain a beautiful, stable, long-term shape that justifies the scarring.” In the search for a permanent result some authors used foreign material like silicone sheets [36, 37] or absorbable mesh [38]. In 1981, Johnson [39] and later Goés [8, 18, 40–43] and Sun et al. [44] reported good, permanent results and no recurrent ptosis by inserting polypropylene or polyester mesh. Goés [18] treated 392 patients with the longest follow-up of 15 years. Goés’ technique, however, was not generally accepted because many surgeons were reluctant to insert mesh in the female breast, either fearing local complications like infection or extrusion or because of possible interference with oncologic survey. In the meantime, research showed that inserting mesh did not interfere with X-ray imaging or palpation of the breast and that mesh could be inserted safely without serious complications [8, 18, 41]. However, Goés’ technique turned out to have a steep learning curve and the mesh needed to be adjusted and custom manufactured for each individual case [3, 18, 43]. The technique was lacking a system which made it impractical. In search of a practical, versatile, easy-to-introduce mesh to act as a suspensory system, clinical research on various shapes of implant and various mesh material was performed. Initially, flat mesh was used. In each case a three-dimensional (3D) form was custom-made during the operation. This procedure was difficult and time-consuming and it was difficult to obtain symmetry. In some cases the margins that were sutured together became dehiscent resulting in local bottoming out. Ultimately, a much more practical, prefabricated, 3D mesh was developed. Different shapes and sizes were tested in the search for the optimal implant (Fig. 1).

As permanent reinforcement was mandatory, various nonabsorbable types of mesh were tested. Initially, a flat

polypropylene mesh was used (manufactured by Bard, Tyco). Because of the rather rigid structure, the margins were often palpable, especially around the areola complex and sometimes rippling was observed. Although palpable, two consulted oncologic surgeons were convinced that this did not interfere with an appropriate palpation of the breast. Second, Vypro mesh (polypropylene-vicryl combination) was tried (manufactured by Johnson & Johnson). This material was less rigid; however, because it is partly absorbable, reinforcement was less permanent and it could not be made in a preshaped form. Next, a much softer grid-structured polyester mesh was used, first in a flat form and later in a preshaped form (manufactured by Aspide). It was barely palpable and no rippling occurred. However, because this mesh could stretch in one direction more than in the other, the final shape could be less predictable.

Eventually, a 3D, preshaped, woven polyester mesh was created in different sizes (manufactured by Aspide) (Fig. 2). It is strong because of its structure but feather-soft and has equal stretch abilities (Fig. 3). It is not palpable under the skin. This appeared to be the ideal implant for the



Fig. 2 Three-dimensional woven mesh



Fig. 1 Different sizes, different material



Fig. 3 Feather soft

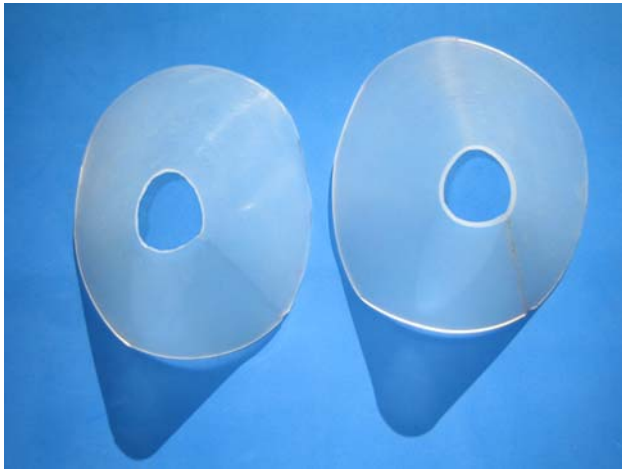


Fig. 4 Sizers

female breast. In the mean time transparent sizers were developed to measure the size and facilitate the implantation (Fig. 4). The implant and sizer combination makes up the system called the Internal Bra System (Fig. 5). It was used in mastopexy, breast reduction, and contralateral correction after breast reconstruction.

Materials and Methods

Clinical Experiments

Three patients received, with informed consent, an Internal Bra System on one side and a classical mastopexy on the other.

Technique

Contrary to classic types of mastopexy, the shape in the Internal Bra System procedure is dictated by the mesh implant and not by the skin flap design. The flaps just follow the mesh. This has fundamental implications for the technique. Less skin needs to be removed and closure is tensionless. Any appropriate skin resection pattern can be used. In this series a vertical scar technique (Lejour) [45], a small T shape (Lejour with small horizontal extension), or a Wise [46] pattern skin resection was used depending on the amount of excess skin (Tables 1–3).

Skin flaps about 1 cm thick are elevated from the total circumference of the glandular tissue, over the pectoralis and serratus fascia, up to the second rib, and at the inframammary fold down to the rectus fascia. In case of

Table 1 Patient data

Patients	170
Average age	41.7 (17–65)
Operated breasts	327
Contralateral procedures after reconstruction	8
Otherwise unilateral procedures	5
Mastopexy	169
Reduction	158
Average weight of removed tissue	254 g (range = 24–1224)
Longest follow-up	4.5 years
Mean follow-up	1.4 years
Mean sternal notch to nipple (SNN)	27.4 cm (range = 22–32)
Mean nipple to submammary fold (NSF)	10.0 cm (range = 9–13)

Fig. 5 The internal bra system

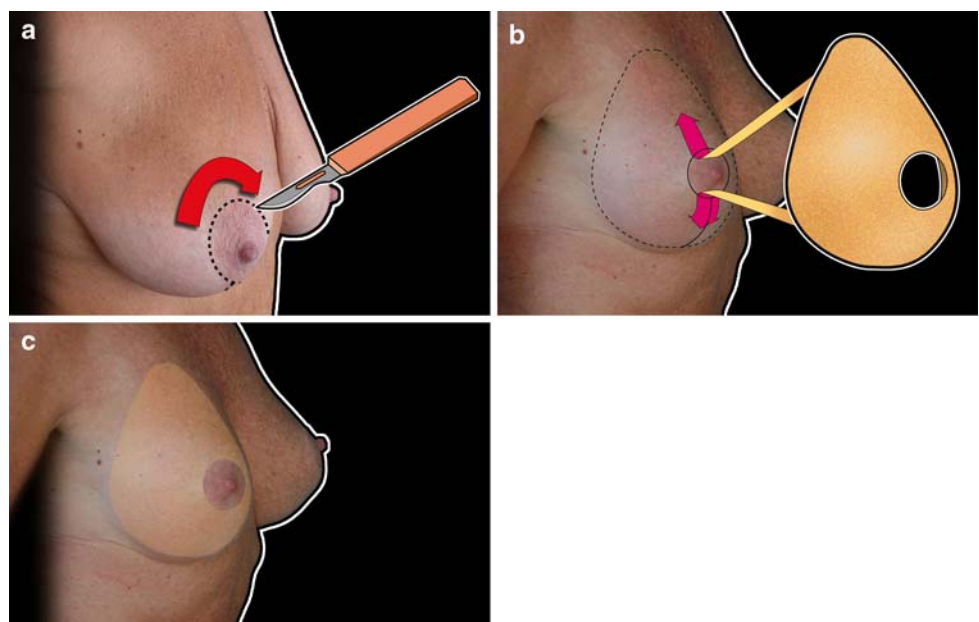


Table 2 Numbers of different meshes used

Flat polypropylene	69
Flat Vypro mesh	163
Flat grid structured polyester mesh	6
Preshaped grid structured polyester mesh	11
Preshaped soft woven mesh	78

Table 3 Resection patterns

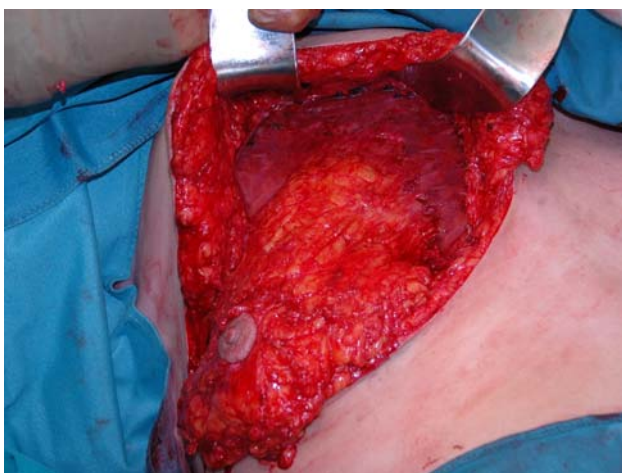
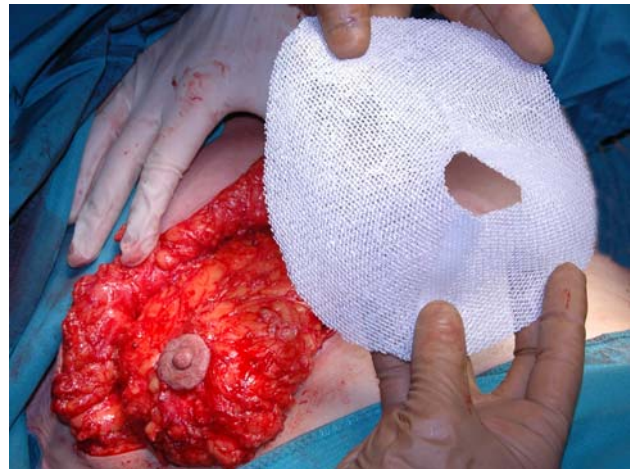
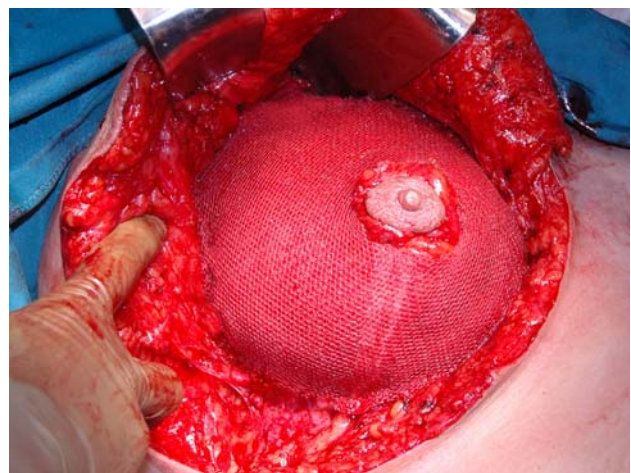
Lejour [45]	45 (13.8 %)
Lejour with small horizontal extension	143 (43.7%)
Wise [46]	139 (42.5%)

concomitant hypertrophy, a glandular reduction is performed, preferably at the superior and lateral side, leaving enough tissue to fill the upper pole. The sizers facilitate the choice of the appropriate implant.

The preformed mesh is placed snugly and free of creases around the gland and fixed high up to the second rib junction and to the pectoral fascia, the natural fixation place of the youthful breast. It surrounds the breast gland like an internal bra, resulting in a permanent desired shape (Figs. 6–8). It is secured in place with nonabsorbable sutures or staples, preventing dislocation, curling up, or migration. Finally, the skin flaps are loosely redraped over the mesh, further adjusted if needed, and sutured without any tension; subdermal closure is with interrupted vycriil 2/0 and 4/0 sutures and intracutaneous closure with running 4/0 monocryl sutures of all wounds. Drains are left accordingly.

Contraindications

Pregnancy, lactation, local infections, irradiation, and previous subglandular augmentation were considered absolute contraindications. Relative contraindications are

**Fig. 6** Dissection high up to the pectoral fascia**Fig. 7** Mesh before implantation**Fig. 8** Implant sutured in place

uncompleted family or high risk of breast cancer. Until now the Internal Bra System was not inserted for ptosis correction in breasts larger than a C cup. In case of larger breasts, concomitant reduction to a C cup was performed.

Results

In no case was recurrent ptosis observed (Table 4). All breasts remained supple, adjusting their shape in a natural way to the direction of gravity. Scar hypertrophy was not seen (Figs. 9–12).

Physical Examination

Although the margins could be felt when polypropylene mesh was used, it did not interfere with physical examination. The soft woven mesh in use in the latest version is



Fig. 9 Preoperative ptosis



Fig. 12 Hypertrophy plus ptosis 6 months after surgery



Fig. 10 Ptosis 6 months after surgery



Fig. 11 Preoperative hypertrophy plus ptosis

not palpable at all, allowing normal physical breast examination. Two consulted oncologic surgeons agreed on these findings.

X-ray Examination

Postoperative mammography was performed in four cases and an MRI scan in one case. The polypropylene mesh could not be detected in the mammography (Fig. 13), the

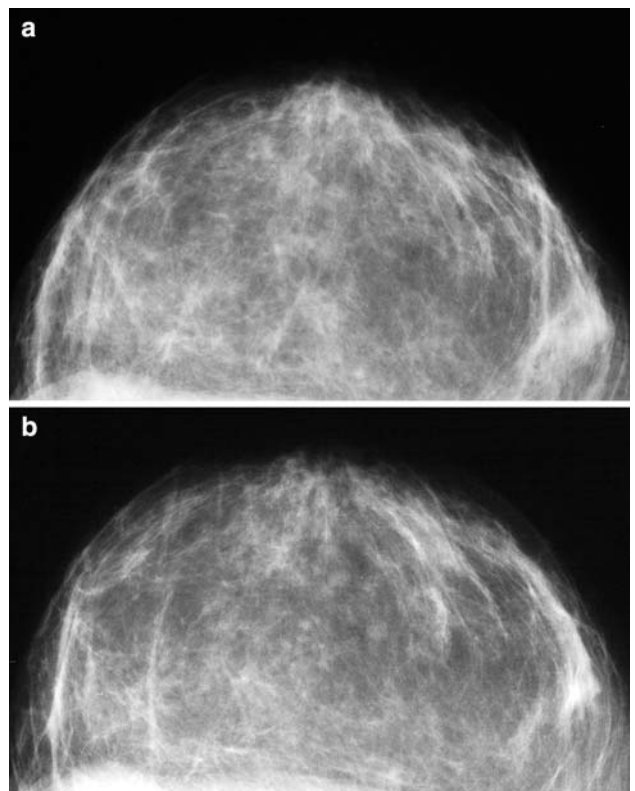


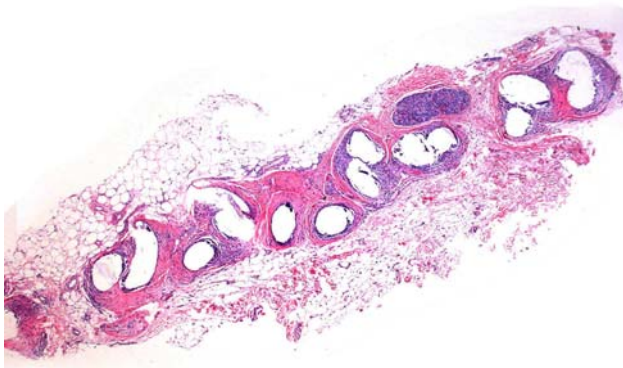
Fig. 13 Mammography 2 years after polypropylene insertion

Table 4 Postoperative measurements

Measurements at 3 months	
Mean SNN	20.7 cm (range = 17–24)
Mean NSF	10.3 cm (range = 9–13)
Measurements at 1 year	
Mean SNN	21.4 cm (range = 17–24)
Mean NSF	10.8 cm (range = 9–13)

Table 5 Complications in 327 breasts

Local infection responding well to antibiotics	2
Abcess needing evacuation	1
Fat necrosis	4
Partial skin necrosis	1
Small area of mesh extrusion needing local correction	2
Hematoma needing drainage	2
Deformity needing minor secondary scar revision	5
Loss of nipple sensation	8
Retraction of the nipple	2
Malposition of nipple needing secondary correction	3
Rippling of rigid polypropylene mesh needing correction	5
Bilateral replacement of polypropylene by woven polyester mesh because of disturbing palpable wrinkling	3
Postoperative detection of breast cancer needing amputation	2
Bottoming out at site of dehiscent sutures in custom-made implant	3
Extrusion	0

**Fig. 14** Mesh embedded in a thin layer of fibrous tissue

polyester mesh was vaguely visible. Four consulted radiologists stated that in all cases unrestricted examination was possible.

Complications

It turned out that all secondary procedures were easily possible. Partial or total mesh resection, reinsertion of a

patch, cutting through mesh, or amputation was easily performed (Table 5).

Clinical Experiment

All three patients who received a one-sided mesh implant and had a classic mastopexy on the other side showed bottoming out on the classic mastopexy side 2 cm lower than on the mesh side 6 months after the procedure.

Histologic Examination

In three cases histologic examination was performed on a piece of mesh removed during a secondary correction 3–6 months after implantation (Fig. 14). It showed mesh embedded in adipose tissue surrounded by a thin layer of reactive collagenous tissue and a mild inflammatory reaction. This is a normal, reassuring, and expected finding.

Discussion

Most women will develop breast ptosis with age. Still, mastopexy procedures (breast lift) are the least performed cosmetic breast correction. Based on statistics from the American Society of Plastic Surgeons (ASPS) and International Society of Aesthetic Plastic Surgery (ISAPS), it appears that about 450,000 mastopexy procedures are performed annually compared to more than 1,000,000 augmentations and approximately 650,000 reductions worldwide. This could be partly because the latter two procedures give permanent results with respect to their main goal, i.e., larger or smaller breasts. Mastopexy procedures and the lifting aspect of breast reduction, however, is temporary [2–7, 13]. According to Grotting and Chen, “All mastopexy techniques are imperfect” [3].

The abundance of techniques for mastopexy indicates that the ultimate solution to obtaining a pleasing and long-lasting result has not yet been found [29]. This is a logical consequence of the fact that almost all techniques rely on the use of local breast tissue in whatever form. De-epithelialization, flap transposition, gland repositioning, or suturing will not alter the physical properties of the tissue, and sagging out is one of them. All techniques create some internal scar formation acting as reinforcement. This varies in each individual and thus is unpredictable, but at best it temporarily slows down the inevitable ptosis. Based on simple physical laws, ptosis will recur sooner or later.

For a permanent result, the holy grail of mastopexy, the attenuated original suspensory system, the Cooper and Würinger ligaments, need to be replaced [47, 48]. Instead of using local tissue, the only other practical option to reach that goal is to insert foreign material with predictable

physical properties. Both materials used in this study, polypropylene and polyester, have been in safe use in medicine for over 40 years [39, 49].

Goés [18] certainly has the most extensive experience in mesh reinforcement of the female breast. Although his approach is sound in theory, his technique was not generally accepted for several reasons. First, there is a natural and understandable reluctance to place foreign material in the female breast, fearing infection, unfavorable aesthetic outcomes, palpable or visible deformities, extrusion, fibrosis, or capsular contraction [8, 18]. However, at the same time, plastic surgeons place silicone prostheses and fat transplants into the breast, they perform extensive dissections for reduction or mastopexy resulting in scar formation, and move gland tissue all around and sometimes even partly under the pectoralis muscle [13, 18, 19, 50]. Occasionally, fat necrosis or worse can occur after breast correction, adding to the inevitable scarring.

From the literature it has become clear that mesh could be inserted safely in the breast with a low rate of complications [8, 18]. No reports could be found on excessive fibrosis or capsular contraction, nor on high infection or extrusion rates. In our follow-up of 4.5 years, we came to the same conclusion. This is in contrast with the experience with mesh used in abdominal surgery where it often gives rise to an intense inflammatory response that results in scar plate formation, increased stiffness of the abdominal wall, and shrinkage of the biomaterial [49, 51]. This experience is probably the main reason for the reluctance of using mesh in the female breast. The apparent discrepancy in the behavior of mesh used in different parts of the body could be because in abdominal surgery the mesh is located on the rigid fibrous abdominal fascia, while in the breast it is located between layers of fatty tissue (Fig. 14). The histologic findings in this study and others [18, 43] show that the mesh is tolerated well in the fatty subdermal tissue of the breast where it is surrounded by a thin layer of connective tissue, leading to the proposed reinforcement of the breast.

Another factor in the poor acceptance of mesh insertion is the fear of impaired physical and X-ray examination. Research by others, as well as our observations, clearly shows that the use of mesh does not interfere with the visualization and analysis of the breast's parenchyma, and the implant does not hamper proper oncologic physical breast examination [8, 18, 43, 52].

A third factor is that Goés' technique has a steep learning curve and it lacks a system or an available preshaped product, making it impractical [3, 8, 18]. The Internal Bra System solves this problem. It is designed as an easy-to-insert and versatile system and it comes in different sizes of 3D preshaped mesh and with concomitant sizers.

The complications encountered with the Internal Bra System are within acceptable and expected limits. No total

extrusion was observed, not even in the one case of a major abscess formation. Scar hypertrophy is common in mastopexy and reduction mammoplasty [4, 6, 26, 53, 54]. These sequellae were not encountered in this series nor in the other reported series with the use of mesh [44], most likely because, contrary to many other techniques, the wound is closed without any tension, leading to superior, less conspicuous scars. The direct mesh-related complications such as rippling and small partial extrusion were limited and occurred only in the polypropylene mesh cases. The quest for the optimal physical properties of nonabsorbable implants resulted eventually in the design of a preshaped, soft, woven polyester mesh that gave superior results with respect to softness and shape and no complications. Polyester offers considerably more flexibility, less stiffness, has significantly lower connective tissue formation and better tissue integration compared with polypropylene [55–57]. This explains the clinical finding in this study that contrary to polypropylene mesh, the 3D woven polyester mesh in the breast is not palpable.

Recurrent ptosis was not observed. The short-term postoperative measurements indicate a lasting shape without recurrent ptosis. Long-term follow-up is needed to prove that this finding is stable, as predicted by the outcome of the Goés series. Definite proof that the mesh prevents recurrence was illustrated in the three clinical experiments where the patient was her own control and in the three cases of local bottoming out at the location of dehiscent sutured margins. It clearly indicates where the breast tissue would be on the way to recurrent ptosis had the mesh not been inserted.

The longest experience and follow-up in this series is with the use of polypropylene. Although pleasing results without recurrent ptosis could be obtained, the rather rigid structure of the polypropylene mesh yielded less favorable outcomes in some cases. For that reason replacement with the softer polyester was indicated in three patients. The superior characteristics of polyester seem to fit better in breast corrections. Although the 3D woven polyester mesh has been in use for only 1 year, the results show that it equals the use and outcome of the polypropylene but is far superior with respect to natural softness, indicating that its use seems the best method of obtaining a long-lasting result in breast ptosis correction.

A permanent result is desired not only in mastopexy and reduction mammoplasty but also in breast reconstruction cases. The recurrent ptosis of contralateral correction after a rather rigid breast reconstruction with a prosthesis is often embarrassing. The Internal Bra System can prevent this.

Like all other surgical techniques scar formation with the Internal Bra System in the breast is inevitable. Although completely encircled by nonpalpable mesh, the unity of the gland as a whole is not jeopardized at all. It

does not violate tissue compartments, contrary to some other surgical techniques [13] that lead to more internal scarring and possible disturbed breast cancer screening [7].

All secondary procedures involving mesh could be performed uneventfully. If necessary, the mesh can be incised, adjusted, or even removed to convert the procedure to a classic mastopexy, as shown in this series and in the literature [18]. In case of malignancy, the diagnostic sentinel node procedure could be less conclusive with the Internal Bra System, like in some other cosmetic breast corrections.

Data on pregnancy and lactation or on extreme gain or loss of weight after mesh insertion in the female breast is not available from our series.

Conclusion

Up to now an easy-to-perform, generally applicable and accepted versatile technique for mastopexy, leading to a long-lasting result that justifies the scarring was not available, as reinforcement with local tissue inevitably leads to recurrent ptosis. Mesh implantation, acting as an internal bra, fulfills the sought-after criteria. The Internal Bra System appears to be safe and reliable and does not interfere with breast examination any more than other mastopexy procedures. Nahai [5] noted: “Awaiting is the development of a suitable internal mesh to use in the Goés technique.” With the Internal Bra System we think we have found that. Further experience and investigation should reveal the long-term effects.

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