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ORIGINAL ARTICLE

Improvements in Transaxillary Breast Augmentation

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Abstract
Background Roughly 90% of breast augmentations are done through the submammary approach, yet patients, given the choice, sometimes choose the transaxillary approach, with the inconspicuous scar hidden in the axilla. Because the transaxillary approach is technically demanding and is performed relatively rarely, many plastic surgeons never master the technique.
Methods From 1988 to 2009, 140 patients underwent transaxillary breast augmentation by the author, who developed several innovations and improvements for planning of this operation, its technical execution, and postoperative care. Among these innovations are a new implant selection system, the "boomerang incision," the technique for inserting anatomic teardrop-shaped implants through the axilla, submuscular and subfascial implant placement, a new instrument called the breast implant pusher, and use of intermittent regional postoperative analgesia.
Results Implementation of the aforementioned modifications and innovations improved the overall quality and consistency of surgical results. It was proved that anatomically shaped breast implants could be inserted through the axillary incision and correctly positioned in the subfascial and submuscular location. The transaxillary technique is contraindicated for patients with ptotic, asymmetric, or tubular breasts.
Conclusion Transaxillary augmentation mammaplasty without routine endoscopic assistance is a safe method with predictable results and a high rate of patient satisfaction. The transaxillary technique offers the advantage of locating the surgical scar off the breast. It requires closer supervision during the first few postoperative months compared with the submammary or periareolar technique because it is more difficult to place and maintain implants at the proper level using the transaxillary approach.

Keywords Breast augmentation · Mammary implants · Surgical technique · Innovations · Transaxillary breast augmentation

Breast augmentation is a seemingly straightforward procedure, and breast implants made of silicone elastomer and filled with silicone gel have been the gold standard since 1964 [1]. Transaxillary breast augmentation (TBA) is technically more demanding than the submammary or periareolar approach. Dissection and inspection of the pocket is cumbersome and insertion of the implant through the narrow channel requires special training. On the other hand, TBA offers the advantage of a remote incision site, hidden in an aesthetically acceptable area.

Since its introduction in 1972 [2, 3], transaxillary surgical techniques and implants have undergone important modifications [4–8]. TBA was frequently used during the 1980s when saline-filled implants were dominant [5]. This was followed by a period of relative oblivion for the TBA when high-cohesive, anatomically shaped implants were the primary choice for the majority of surgeons in Europe [9–11]. High-cohesive implants have minimal pliability and during the 1990s they were available only in anatomic shapes and thus required precise placement which made the submammary incision mandatory. In the last 4 years softer cohesive gels have been introduced to the market, and soft cohesive implants are available in both round and teardrop

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shapes, bringing back the possibility of using the TBA technique. The purpose of this communication is to share the experiences of the author and report on several original innovations.

Materials and Methods

A total of 140 patients underwent TBA from 1988 to 2009. Primary augmentation was carried out in 129 patients and secondary augmentation in 11. In the secondary cases, six patients were initially operated on elsewhere. During the years 1988–1997, round implants filled with liquid silicone or normal saline (Siltex, Mentor Corp., Santa Barbara, CA, and Crystalline Paragel and Crystalline Inflatable, Eurosilicone Ltd., now part of MediCor Ltd., Las Vegas, NV), were used. In the years 1998–2004 I worked only with high-cohesive anatomic implants using the inframammary incision. In 2005, I switched to soft cohesive gel implants and went back to TBA in suitable cases, using implants with both round and, in 28 patients, anatomic shapes (Eurosilicone Ltd). Patient ages ranged from 18 to 48 years (median = 24 years). All patients were operated on and followed up by the author. They were seen and evaluated routinely after 1 week, 3 months, and 1 year after augmentation. After this time, patients returned to the clinic only for treatment of complications or other troublesome outcomes.

The author and his team worked out several innovations and improvements in the TBA procedure and postoperative care. The new implant selection system, the new "boomerang incision," the technique of inserting anatomic, teardrop-shaped implants through the axilla, submuscular and subfascial implant placement, the "double lubrication technique," the new instrument called the breast implant pusher, and intermittent regional postoperative analgesia are the new techniques and tools that were modified or introduced.

Patient Selection

TBA is frequently the patient's choice if she is informed of such an alternative. It is particularly suitable for women who would like to keep implants secret in intimate situations and/or like to sunbath topless. The method is appropriate for both nulliparous and parous patients. Only patients with minor ptosis ($\leq$2 cm) and minor asymmetries are accepted. Obese patients and those requesting very large implants (>400 cc) are excluded. Further contraindications are major asymmetries and ptotic and tubular breasts. A relative contraindication is if the patient lives very far away, which makes postoperative monitoring of the implant position and its adjustment with the breast straps not possible.

Digital photographs were taken during the initial consultation and were later displayed in the operating room (OR) during the procedure. The standard projections were frontal and right three-quarter views. A left three-quarter view was also obtained in patients with asymmetric breasts. Special projection for the TBA was with hands elevated above the head, which best reveals the position of the inframammary fold (IMF) and the presence of differences in the shape of the mammary gland. Photographs were repeated at the time of follow-up.

Preoperative Evaluation

Implant size was chosen together with the patient, paying attention to her wishes and expectations and considering many factors such as her height and weight, width of her hips, shoulders, and thoracic cage, breast appearance including the degree of ptosis, thickness of the subcutaneous tissue in the upper and the lower pole of the future breast, professional occupation, previous deliveries and future pregnancies, martial status, and age [11] (H. Solz, personal communication, 2006).

Breast and thoracic cage asymmetries were detected, incorporated into the preoperative design, and corrected as much as possible. Limits of the dissection were delineated depending on anatomy of the breast and size of the implant. About 2 cm were added at the upper pole to eliminate an angle on the breast contour, which can be caused by the implant in thin people [11, 12].

The distance between the nipple and the IMF was assessed. The submammary crease was frequently lowered 0.5–1.5 cm, taking into consideration the vertical parameter of the breast and the height and volume of the implant, in order to maintain the proper nipple position on the soon-to-be enlarged breast mound. The mammary lines were drawn, extending on the thoracic skin below the breast. This allowed accurate centering of the implant.

Implant Selection System

Optimal implant selection is often difficult and can create disagreement between surgeon and patient. The new "3-Step Breast Implant Selection System" for round implants was created in cooperation with Eurosilicone Ltd. to professionally assist patients in determining the desired breast volume and to assist surgeons in choosing the implant to meet this goal. *Step # 1* is determination of the desired breast volume with the aid of the external sizers; these are available in sizes 1–6. *Step # 2* is determination of the optimal implant width. This is done using a mathematical formula that takes into account the existing breast width, the desired width of the cleavage, and the thickness of tissues at the upper pole of the breast. The equation used is

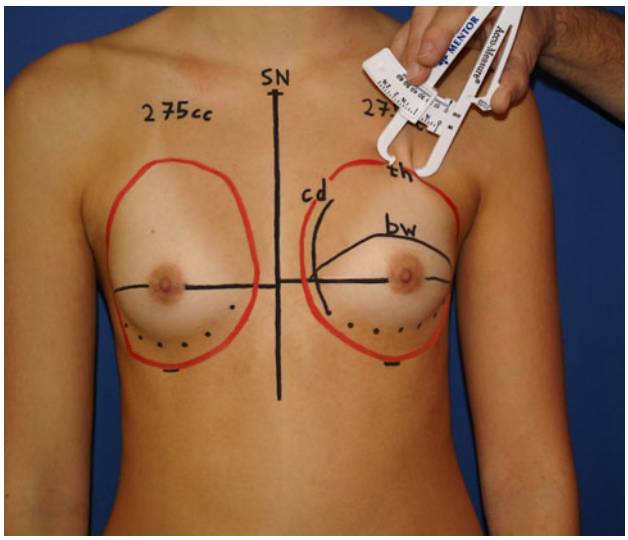

Fig. 1 Measurements used for the implant selection system (see text)

$cd \times 2 + bw - th$, where *cd* is the difference between the existing and the desired cleavage, *bw* is breast base width, and *th* is the superior pole thickness. *Step # 3* is determination of the proper implant (Fig. 1). The system chart will suggest an appropriate implant to provide the desired breast volume, cleavage, and lateral protrusion.

Operative Technique

Review of four instructional brochures from leading implant manufacturers revealed that no clear consensus exists regarding placement of the axillary incision. Drawings provided by manufacturers were in part erroneous and misleading (Fig. 2). Preoperative marking should be done while the patient is standing so that it can be determined whether the future scar will be inconspicuous. I propose the "boomerang incision"; it gives the best access and is well concealed when standing (Fig. 3). The incision starts in the apex of the armpit, 2 cm posterior to the border of the pectoralis major muscle, and runs parallel to it in the vertical downward direction for 2 cm. The incision then turns posterior at an 80° angle and runs for another 2 cm.

The principles of rigorous sterility, as proposed by Mladick [13], are used. After the standard prep in the OR, the whole chest is covered with protective OpSite film (Smith & Nephew, Hull, UK). Talc-free gloves are used and changed just before the insertion of the implants. All operations are carried out with the patient under general inhalation anesthesia via a laryngeal mask. The anterior part of the axilla and breast margins are injected with a total of 25 cc of 1% xylocaine with 5 μg adrenaline/ml (AstraZeneca, London, UK) diluted with 50 cc of normal saline. In general, perioperative antibiotics are not used.

Placement of implants is subfascial and submuscular, i.e., the pocket is created in the space between the posterior blade of the fascia, encasing the major pectoral muscle and the epimysium on the posterior surface of this muscle (Fig. 4). In the lower half of the pocket, the posterior blade of the pectoral fascia becomes thin and is interrupted. Dissection begins under direct vision using an electrocautery knife and long Mayo scissors. The lateral thoracic vein and its branches are always encountered and if injured must be promptly controlled. Well under the muscle dissection becomes blind and proceeds using the index and long fingers and Reynolds (Padgett/Integra, Plainsboro, N.J.) and Solz (Medicon, Tuttlingen, Germany) dissectors (H. Solz, personal communication, 2006) (Fig. 5). Dissection runs from the pectoral edge toward the nipple, where the major and minor pectoral muscles are easily separated. From the nipple the pocket is created with inferior to superior movements in the upper direction and medial to lateral movements in the lower part. This preserves the neurovasculature, in particular, the anterior branches of the 5th, 6th, and 7th intercostal nerves which provide sensation to the nipple. The medial lower attachments of the pectoral muscle to the ribs are distended and partially divided. Then, medial to lateral sweeps with the Reynolds instrument elevates the oblique and transverse abdominal muscles. A cold-light retractor and, since 1997, endoscopic equipment are always available when needed.

Microvac drains (Maersk Medical A/S, Lynge, Denmark) and an epidural catheter are introduced into the pocket. Placing the anatomic implant with the textured surface in the proper position through an axillary incision can be difficult so insertion is facilitated by the double-lubrication trick. The whole implant is wetted with normal saline. Then sterile 2% xylocaine gel (AstraZeneca) as a second lubricant is spread on the part of implant that is introduced first. It is also placed into the pocket through a soft catheter (Fig. 6). The implant glides in the insertion channel but not on the surgeon's gloves.

Final adjustment of sideways projection is made with implants in place. Breast symmetry, projection, and lateral protrusion are visually checked from below, looking from the patient's feet. Then, the patient is half-seated or (ideally) seated, while still asleep and her breasts are observed and evaluated from various angles. This requires special arrangements for draping and anesthesia and must be planned in advance.

Lowering the implant to the bottom of the pocket during the operation can sometimes be difficult. The commonly performed maneuver of pressing the implant with two fingers is ineffective so for this purpose I constructed a new instrument, the breast implant pusher (Fig. 7) (C.W. Heljestrand Surgical Instruments, Arjeng, Sweden). It has been

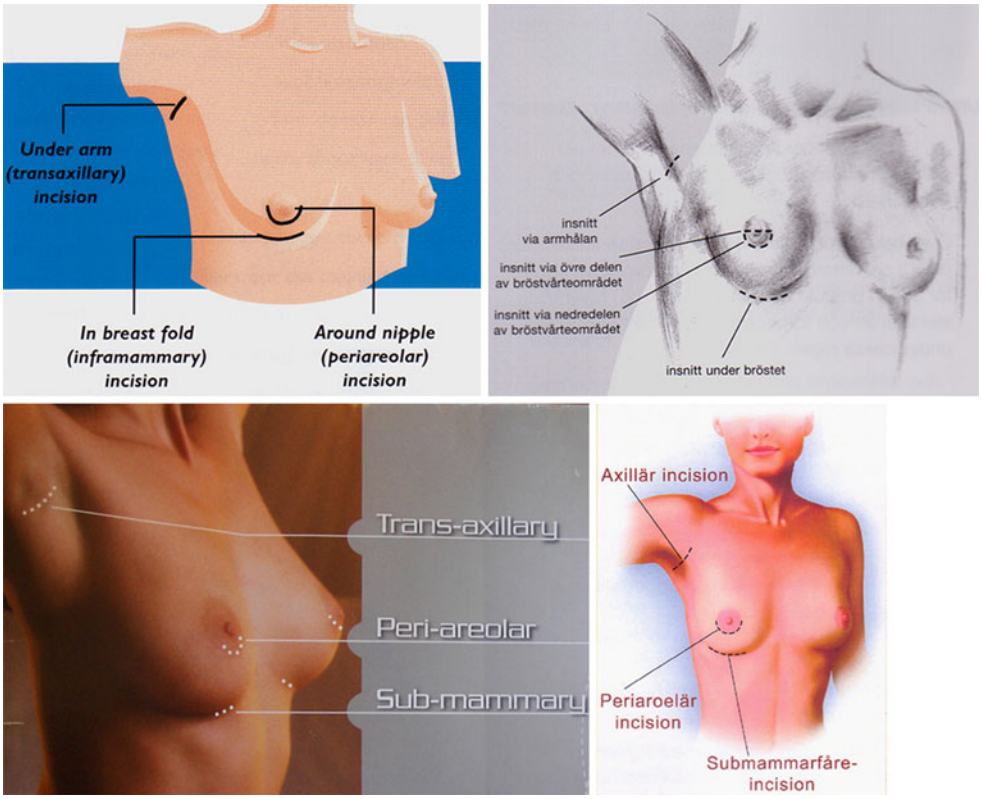

Fig. 2 Transaxillary incision as depicted in the instructional brochures from the four leading manufacturers of silicone implants displayed clockwise: Eurosilicone, Inamed/Allergan, Silimed, and Mentor

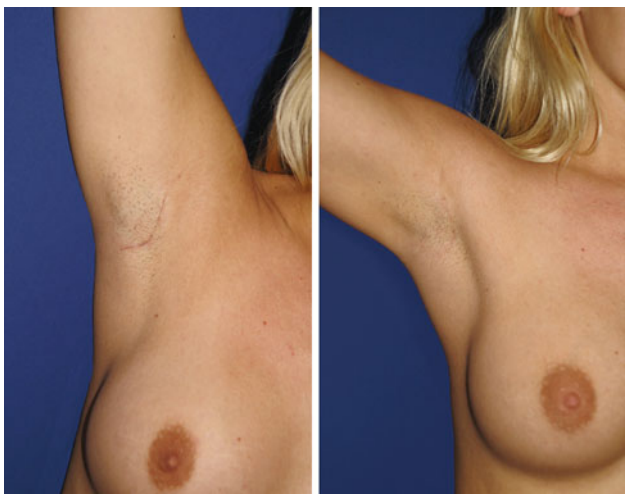

Fig. 3 The boomerang incision. Appearance 4 months (*left*) and 1 year (*right*) after the operation

Fig. 4 The plane of dissection is between the posterior blade of the major pectoral muscle fascia (*arrow*) and the epimysium on the ventral side of the major pectoral muscle

tested clinically for 2 years and it facilitates placement of the implant in the proper position.

Wound closure is done by a few single 3.0 Vicryl sutures approximating the subcutaneous fat. Intracutaneous running 4.0 Prolene (Ethicon GmbH, Norderstedt, Germany) closes the skin. All patients were hospitalized for one night and remained under the care of a specially trained registered nurse.

Postoperative analgesia is improved by flushing the implant pocket with long-acting local anesthetic just before the insertion of the implants. We use Narop (AstraZeneca, London, UK) in 10 mg/ ml, diluted with normal saline (1:4

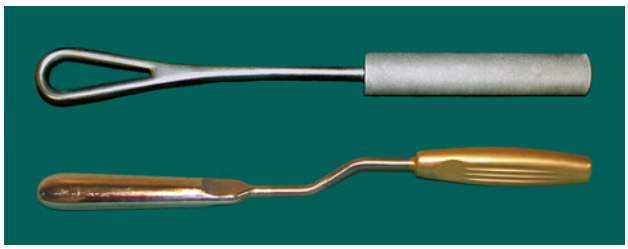

Fig. 5 Reynolds (*above*) and Solz (*below*) dissectors. Reynolds creates the space and Solz gives volume to it

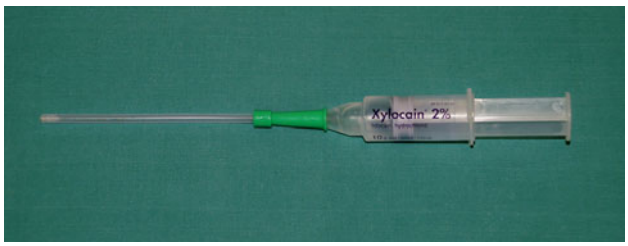

Fig. 6 Factory-prefilled syringe with 2% xylocaine gel and 14-gauge catheter

dilution), 25 ml per site. Chirocaine (Abbott, Abbott Park, IL, USA) can also be used for the same purpose. The epidural catheter introduced into the implant cavity provides continuous regional analgesia [12]. Additional diluted Narop solution (10 cc per breast) is given every 3–6 h during the patient's stay in the clinic.

Results

This article is primarily concerned with the technical improvements in TBA. The patients in this study included both primary and secondary augmentations that used implants with various filler materials. The skills of the surgeon and the surgical techniques used were also quite different during the learning period compared those of recent years. Therefore, the implant material and its impact on the end result were not analyzed in depth.

Twenty-eight patients with anatomic implants had good symmetry and no implant rotations were observed. Aesthetically, all patients expressed satisfaction with breast enlargement without a visible scar. The axillary incision parallel to and below the major pectoral muscle occasionally yielded a scar that could be seen caudally when standing. With the introduction of the boomerang incision this drawback was eliminated, and patients judged their axillary scar as well concealed and often practically invisible, even when they had their arms elevated (Fig. 3, 11). The double-lubrication technique cut the time to insert the implants and the strain on the surgeon to about one third of the previously required. The described breast implant pusher and the skillfully applied breast straps (Fig. 9), maintained for several weeks after the operation, were both helpful in retaining the mammary implant at the optimal level.

Sometimes, concerns are voiced that TBA weakens the function of the major pectoral muscle. TBA, as every other procedure that involves elevation and partial division of the major pectoral muscle, produces a certain amount of regional fibrosis. However, my own observations confirm that this has no impact on the function of the major pectoral muscle in daily life (Fig. 10).

My subjective impression, based on clinical observations during the last decade, is that the postoperative, topical, long-acting anesthetic regimen used for TBA lowered the pain level, which is higher in TBA patients compared with that of those operated through the submammary incision. With Narop shield, TBA patients required much lower levels of more toxic analgesics such as opiates.

Complications

Most complications occurred during the first few postoperative years, when I was beginning to learn the technique (Table 1). Bleeding appeared in two patients: In one case it originated from the perforating vessels at the pectoralis major medial attachment to the ribs, necessitating a

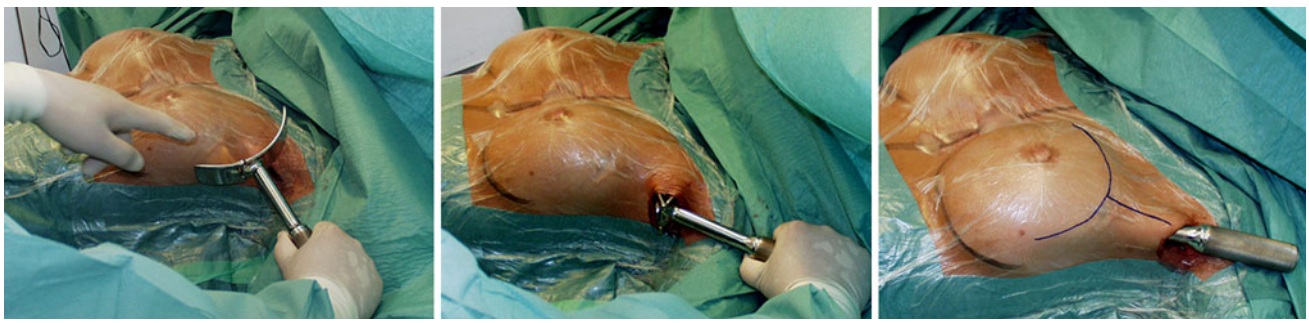

Fig. 7 The breast implant pusher

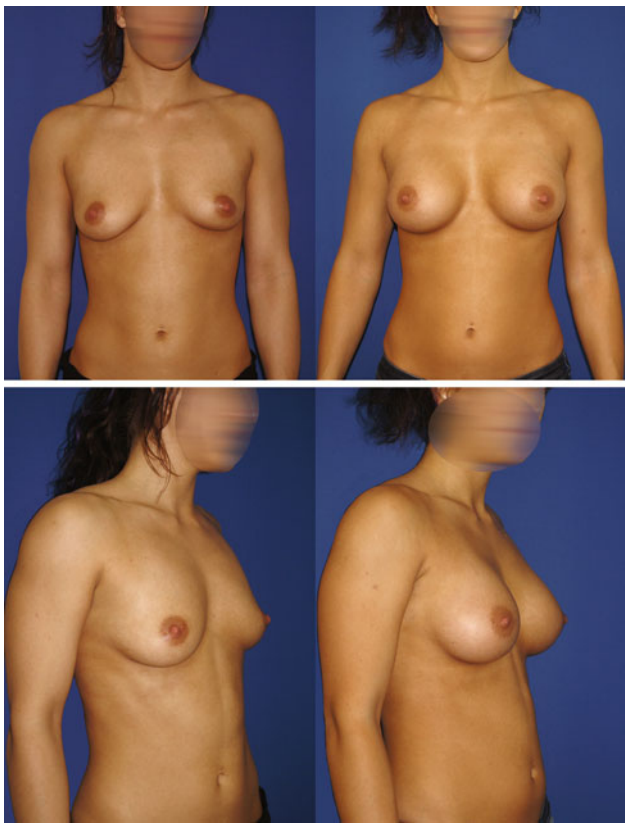

Fig. 8 A 25-year-old nulliparous woman 1 year after augmentation with 325-cc high-profile anatomically shaped implants filled with soft cohesive gel

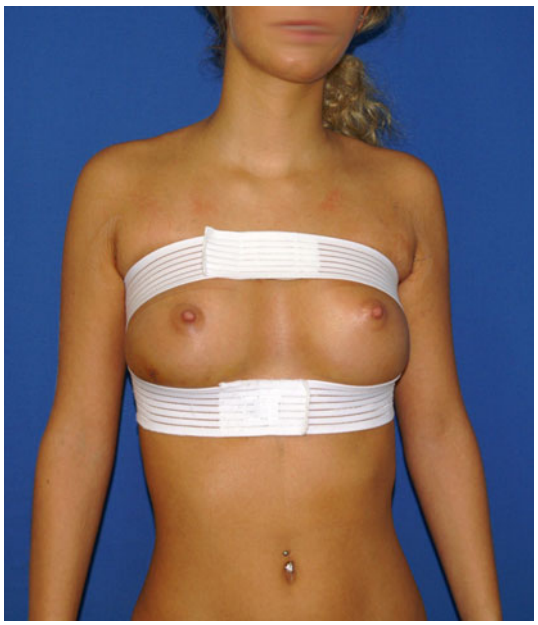

Fig. 9 Modern breast straps prevent both upward and downward dislocation of the implants. The pressure should be applied judiciously

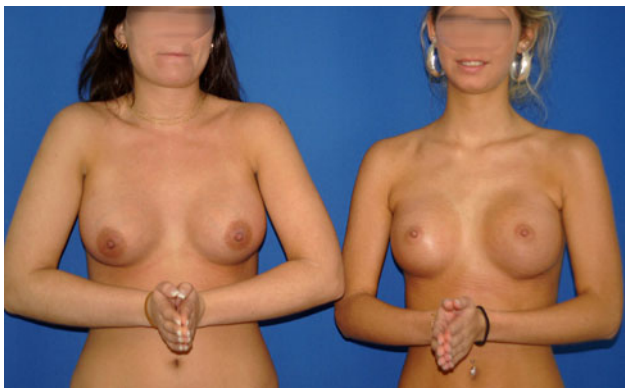

Fig. 10 Two 20-year-old women. The pectoral major muscle function is normal 2 months after transaxillary breast augmentation (TBA) with round high-profile 300-cc implants (*left*) and 325-cc anatomic implants (*right*), both filled with soft cohesive silicone gel

submammary incision. In the other case bleeding was in the axilla.

Twelve patients (8.5%) required secondary surgical intervention because of a high-riding implant. Nine were nulliparous women with slim bodies. In eight patients implant position was corrected by the transaxillary pushdown (Fig. 11), and in four through the inframammary incision.

Three patients reported decreased nipple sensation in one breast each. Hyperesthesia of the nipples and/or breasts occurred in eight thin patients with a tight breast envelope. Paresthesias in the lower part of the axilla and on the inside of the upper arm were common but transient and faded after about 3 months.

There was an unsightly scar in the axilla in 10 patients (7%). One reason for this was occasional axillary folliculitis. In a few cases local inflammation was due to intolerance of the intracutaneously placed resorbable Monocryl (Ethicon, Norderstedt, Germany) suture. This may have been caused by bacteria in the sweat glands and the moist, warm environment. I switched back to 4:0 Prolene, changed the design of the incision (boomerang) and the problem was eliminated. During the last 2 years, 24 of 26 patients enjoyed breast augmentation with practically invisible scars (Figs. 3, 8). One patient was black and had slightly hypertrophic scars, and in one patient the scars widened, requiring a secondary correction.

Table 1 Complications associated with transaxillary breast augmentations performed during the years 1989–2009 ($n = 140$)

Type of complication	No. patients (%)
High-riding implant	12 (8.5)
Unsightly scar	10 (7)
Hyperesthesia of the nipples and/or breasts	8 (6)
Decreased nipple sensation	3 (2)
Bleeding	2 (1.5)

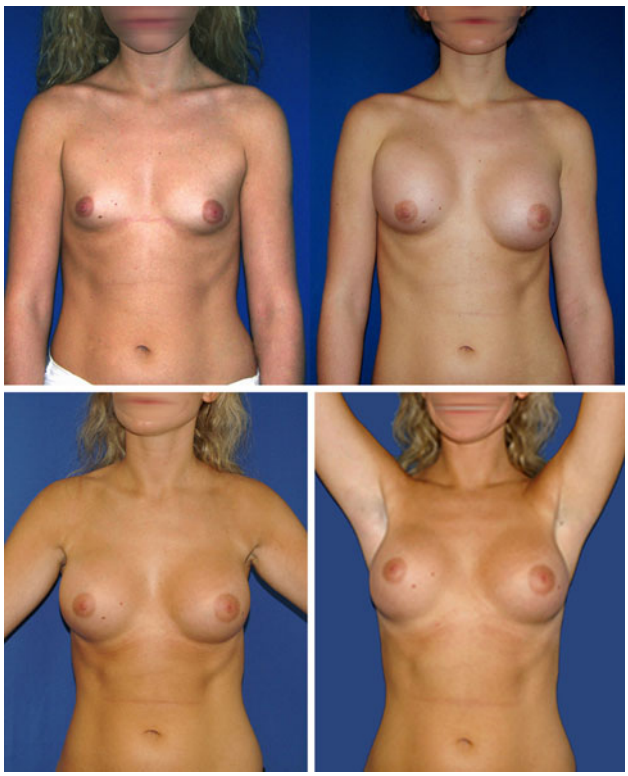

Fig. 11 A 21-year-old woman (*above left*) with breast asymmetry before augmentation. (*Above right*) Three months after TBA with 325-cc high-profile round cohesive implants and just before the transaxillary push down because of high-riding implant in the right breast. (*Below*) Symmetrical breasts 18 months after the primary augmentation

Discussion

Achieving breast augmentation by means of silicone mammary implants without a visible scar on the breast is an optimal outcome from both the psychological and the aesthetic point of view. Despite this, 92% of all breast augmentations (5459 patients) performed in Denmark since 1999 were carried out using the submammary incision [14]. Denmark is probably the only country with a national register of all cosmetic breast augmentations and must be commended for this.

Hitherto only round implants were used by the vast majority of surgeons for TBA, and consequently TBA was precluded and patients were deprived of its benefits if the anatomically shaped implants were chosen [6, 7, 15–17]. Graf et al. [4] first reported placing full-height, anatomic, high-cohesive, small (155-235 cc) implants through the axilla. This report is probably the second that describes the feasibility of the use of teardrop-shaped implants in transaxillary augmentation mammaplasty. In the present series, anatomic implants of 225-325-cc volume (mean = 284, median = 275 cc) were used.

In our recent study [18], only 30% of patients judged their inframammary incision as "very good." On the other hand, overall satisfaction with the scar in the axilla was very high, more than 90%. This agrees with the findings of the Freiburg group in which safety, complications, and satisfaction of patients undergoing breast augmentation by the submammary and transaxillary approaches were evaluated [16]. An axillary scar is also an advantage for nonwhite patients, eliminating the risk of a visible hypertrophic scar or keloid. A widened scar in the axilla can be easily revised after 1 year under local anesthesia. The final, postrevision scar is usually excellent.

Level discrepancies and irregularities of the inframammary fold are frequent frustrations with the TBA technique. The incidence of these situations in this series is 8% and include the learning period of the surgeon; it also depends on the characteristics of the patients. Slim, nulliparous, young women with tight chest tissues were predominant in this Stockholm population. In this study, the probability of cephalad displacement of the implant in such patients was larger (9/12) compared with parous women of normal weight or overweight. Most of these incidences could be avoided by meticulous planning, possession of the proper instruments, including the breast implant pusher, proper design of the pocket, and skillful postoperative management with sophisticated straps (Fig. 9).

TBA requires longer OR time as the surgeon learns the technique, but after the learning curve has flattened it takes approximately the same time to perform as augmentation through the submammary approach, which takes about 50 min for the author. The double-lubrication technique simplified the most cumbersome sequence of the TBA operation. I have noticed, as have Munhoz et al. [17], that some plastic surgeons have an aptitude for this technique, but others will never master it satisfactorily.

In my own experience, and that of others with a high volume of TBA procedures [15, 17] (H. Solz, personal communication, 2006), after negative findings in 50-70 cases, I stopped routinely performing endoscopic inspection but keep the endoscopic equipment available in case of unexpected difficulties when creating the pocket or greater bleeding. Endoscopic assistance has several drawbacks, as pointed out by Munhoz et al. [17]. Among them are the high cost of the equipment, need for the special training, and prolonged operation time.

Recently, there have been concerns raised that TBA disrupts the lymphatic channels in the axilla and disturbs the accuracy of future sentinel lymph node mapping if the patient later develops breast cancer [19, 20]. In general, two lymph trunks run superficially in the breast parenchyma and connect the areolar area with the lower axillary region. Munhoz et al. [21] obtained pre- and postoperative lymph scintigraphies in patients undergoing TBA. They

pointed out that using the subfascial technique, first described by Graf et al. [4], only limited dissection in the axilla is performed. They demonstrated in vivo that the axillary lymphatic channels could be preserved and that sentinel node mapping is feasible after subfascial TBA [22, 23]. The issue is, however, still controversial and the exclusion of the transaxillary and periareolar incisions because of possible interference with the lymphatic mapping and sentinel node identification was pleaded by Shons [20]. All aspects of the possible negative impact of breast augmentation surgery on the diagnosis and treatment of breast tumors should be a part of informed consent.

Using the author's technique of separating the posterior blade of the pectoral fascia and the pectoral muscle, the dissection is oriented even more ventrally and further away from the axillary lymphatic system than in the commonly used separation of the pectoral fascia and the dorsal surface of the major pectoral major muscle [4, 21].

Conclusion

The transaxillary approach for mammary augmentation has the advantage of locating the surgical scar off the breast. TBA without routine endoscopic assistance is a safe and reproducible technique with which both round and anatomically shaped implants could be used. The technique is contraindicated in ptotic, asymmetric, and tubular breasts. TBA requires closer supervision during the first few months compared with the submammary or periareolar technique, but in the properly selected patients the aesthetic results in my opinion are superior.

How to be successful with TBA? First, one has to have knowledge of the anatomy and the theoretical background of the technique. Then, proper patient selection, special instruments, and good team work are necessary. The rest is just experience and confidence.

Conflict of interest statement The author has no financial interest in any of the medical companies mentioned in this article. He has lectured in several courses and symposia organized by Eurosilicone Ltd. and has received lecturer fees. He has no stocks and holds no appointed position with any medical firm.

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