Anterior Intercostal Artery Perforator Flap Autologous Augmentation in Bariatric Mastopexy

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Background: Breast reshaping after massive weight loss represents a challenging procedure because of severe hypoplasia and tissue ptosis. Standard mastopexy techniques are often inadequate to restore a pleasant profile and volume. The authors present their experience with the anterior intercostal artery perforator flap in breast autologous augmentation and remodeling.

Methods: Fifteen bariatric patients (30 breasts) affected by severe breast ptosis and tissue laxity in the upper abdominal wall underwent superior pedicle mastopexy with anterior intercostal artery perforator flap autologous augmentation. The flap was harvested including soft tissues above and below the inframammary fold, extending cranially 5 to 6 cm above the fold and inferiorly over the costal cage and hypochondrium. The flap was completely islanded on intercostal perforators originating from the fifth to seventh intercostal spaces. It was cranially advanced and sutured to the pectoralis major fascia. The medial and lateral borders were sutured together to shape an “autologous implant.”

Results: All of the flaps were transferred successfully. The donor site was always closed primarily and upper abdominal laxity corrected. All of the breasts presented soft at palpation, with no clinical signs of flap necrosis early or late postoperatively. At 1-year follow-up, the breasts maintained good shape and projection.

Conclusions: The anterior intercostal artery perforator flap proved to be a reliable option in bariatric mastopexy. The technique can be performed easily and allows the harvesting of a large amount of tissue with a wide range of motion, providing adequate breast volume and projection without the need for implant placement. (Plast. Reconstr. Surg. 130: 917, 2012.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

The number of bariatric surgery procedures has increased constantly over the past decade. Although they may solve the excess weight and many of its associated comorbidities, the patient is left with excess skin and soft tissue, often leading to referral to the plastic surgeon. The breast profile may be severely distorted as a consequence of massive weight loss, with upper pole deficiency, high-grade ptosis, and lowered inframammary fold. In these patients, mastopexy is challenging, traditional techniques are often inadequate because of poor quality of tissues, and restoration of breast volume is a main issue for a pleasant morphology. The thin overstretched dermis and the poor subcutaneous tissue make implant placement alone unadvisable. Colwell and colleagues already described the use of cadaveric dermis (AlloDerm; LifeCell Corp., Branchburg, N.J.) to supplement suspension of the breast and the implant in an anatomical position, but the ideal volume restoration in this scenario is repre-
sented by the use of autologous tissues. Some flaps such as the rotation-advancement of the superomedial pedicle described by Losken and Holtz or the use of composite tissues nourished by intercostal perforators have been proposed. Starting from Kerrigan and Daniel, several studies investigated the anatomy of perforators originating from intercostal arteries. Pedicled and free flaps nourished by these vessels have been described for hand, breast, and trunk reconstruction. In particular, the use of intercostal artery perforator flaps nourished by lateral branches of the intercostal system (lateral intercostal artery perforator flap) has been previously reported in postbariatric patients. The authors report their experience with the anterior intercostal artery perforator flap, based on anterior intercostal perforator branches originating from the fifth to seventh intercostal spaces, in the field of postbariatric autologous augmentation mastopexy.

**MATERIALS AND METHODS**

**Cadaveric Study**

In our preclinical phase, cadaveric studies were performed to evaluate the viability of the technique, focusing on localization of the perforators and range of motion of the flap. A large skin paddle above and below the inframammary fold was dissected to identify the number and course of the main perforators emerging from the pectoralis major, serratus anterior, and rectus abdominis muscle fascia. On average, two or three musculocutaneous perforators for each intercostal space were found (Fig. 1). Flap dimensions ranged from 6 to 12 cm in width and 6 to 20 cm in length, depending on upper abdominal laxity. Range of motion of the flap was also assessed and was 3 to 5 cm. The greatest advancement has been achieved by sacrificing the most caudal perforators. [See Figure, Supplemental Digital Content 1, which shows a cadaveric study, http://links.lww.com/PRS/A539. (Left) Mobility of the flap. (Right) Increased range of motion after sacrifice of the most caudal perforators.]

**Flap Design and Operative Technique**

Preoperative marking of inverted-T superior pedicle mastopexy is planned. A pinch test of the upper abdominal wall, in supine and orthostatic positions, has to be performed to quantify the amount of skin laxity. The position and number of cutaneous intercostal perforators is identified by a hand-held Doppler probe above and below the inframammary fold, and then the anterior intercostal artery perforator flap is drawn (Fig. 2). Flap dimensions usually extend cranially until the lower margin of the areola (at least 5 to 6 cm above the fold), and inferiorly 5 to 10 cm below the inframammary fold, according to upper abdominal skin laxity that needs to be corrected and always checking manually for feasibility of primary closure. Flap harvesting is performed in supine position using 2.5× loupe magnification: the superior portion of the flap is first dissected cranioducaudally along and pectoralis major fascia; then, inferiorly, the flap is undermined following a plane superficial to the serratus anterior and rectus abdominis muscles fasciae. Major intercostal perforators emerging through the pectoralis major, serratus anterior, and rectus abdominis muscles are isolated. The anterior intercostal artery perforator flap is islanded on perforator vessels.
from the fifth to seventh intercostal spaces, and all of the perforators are initially spared without skeletonizing them through the muscle (Fig. 3). Mobility of the flap is then evaluated. Perforators from the seventh space can be sacrificed to enhance cranial advancement and avoid their compression by primary closure of the donor site. Minor lateral vessels may also be cut to obtain a better breast reshaping (Fig. 4). After careful evaluation of vascularity, the flap is decorticated. The superior border is anchored to the pectoralis major fascia (Fig. 5, left), and the medial and lateral borders are flipped and sutured to each other in a round shape fashion. The “autoimplant” is stabilized to the pectoralis major fascia with absorbable sutures to prevent shearing forces on the perforators (Fig. 5, right). (See Figure, Supplemental Digital Content 2, which shows the surgical technique, http://links.lww.com/PRS/A540. Medial and lateral borders of the anterior intercostal artery perforator flap are sutured to model an autoprosthesis.) Breast shape and projection are checked and abdominal subcutaneous tissue is undermined to achieve primary closure of the donor site, as in a reverse abdominoplasty. The superficialis fascia must be fixed to rib periosteum with nonabsorbable stitches to redefine the inframammary fold in the position planned during the preoperative drawing. Mastopexy is then completed with the patient sitting: the breast is sutured around the “autologous implant” as in a standard inverted-T superior pedicle technique. (See Figure, Supplemental Digital Content 3, which shows an intraoperative view of the breast sutured over the anterior intercostal artery perforator flap in a standard inverted-T technique, http://links.lww.com/PRS/A541.) Suction drains are placed for each side and kept for at least 48 hours.

**RESULTS**

All of the flaps were transferred successfully. The mean size of the flaps was approximately 8.8 \( \times \) 12.9 cm. Usually the flap was harvested on at least three perforators, mainly arising from the fifth space.

Mean harvesting time for a single flap was 40 minutes, and all of the procedures were performed bilaterally with a double team to reduce operative time. Mean operative time was 3 hours, and the use of anterior intercostal artery perforator flap...
tor flaps did not add a significant amount of extra time to the classic mastopexy procedure. All donor sites were closed primarily. Patients were all discharged on the first postoperative day. Physical examination was performed 1, 3, 6, and 12 months after surgery. Within the first month, one patient needed vertical scar revision of a single breast and another presented inframammary fold caudal dislocation that had to be corrected with resuspension under local anesthesia. No other complications were registered. In all follow-up examinations, breasts were soft at palpation, with no clinical signs of flap necrosis. At 12-month postoperative follow-up, a stable result with good nipple position, breast shape, and projection was registered (Figs. 6 through 8). [See Figure, Supplemental Digital Content 4, which shows patient 7, http://links.lww.com/PRS/A542. (Left) Intraoperative view: the “autologous implant” has been shaped and sutured. (Center) Preoperative view. (Right) Photograph obtained 6 months postoperatively.] Upper abdominal skin laxity was always improved.

DISCUSSION

The use of the intercostal vascular pedicle to supply a skin flap was first described by Esser in 1931. Since then, several anatomical studies have investigated the anatomy of these vessels. The anterior intercostal arteries originate from the internal mammary artery from the first to the sixth intercostal spaces and from its terminal branch, the musculophrenic artery, from the seventh to the ninth spaces. These arteries communicate...
the posterior intercostal arteries at approximately the medial third of the ribs, constituting a vascular arcade from which multiple perforators arise. The course of intercostal vessels can be divided horizontally into four segments: vertebral, intercostal, intermuscular, and rectal. Flaps are named by the segment from which their vascular supply arises. The pedicle of the dorsal intercostal artery perforator flap derives from the vertebral supply arises. The lateral intercostal artery perforator flap has the advantages compared with the lateral intercostal artery perforator flap, such as the larger number of perforators and superior mobility. The use of the anterior intercostal artery perforator flap has been described for coverage of epigastric abdominal wounds, for hand reconstruction, for correction of sequelae from augmentation mammoplasty and for reconstruction of sternal defects. Anterior intercostal perforator flaps are also the vessels that nourish the inferior dermolipoglandular flap used in mastopexy procedures and first presented by Dr. Ribeiro at the Congress of the Brazilian Society of Plastic Surgery in 1971. This flap is vascularized by arteries that arise from the fourth to sixth intercostal spaces. In Dr. Ribeiro’s technique, it is harvested from the lower pole of the breast, then advanced cranially as a pedicled flap and sutured to the pectoralis major fascia to provide breast firmness and projection. Modifications of the classic Ribeiro technique to address massive weight loss patients have already been described in the literature. Daniel suggested the passage of the flap under a loop of pectoralis muscle to improve long-term projection whereas Ritz et al. reported their experience in passing the flap only under the pectoralis fascia. However, these procedures im-

<table>
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<th>Patient</th>
<th>Age (yr)</th>
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<th>Suprasternal Notch-to–Nipple Distance (cm)</th>
<th>Upper Abdominal Laxity</th>
<th>Flap Dimension (cm)</th>
<th>No. of Perforators Supplying the Flap</th>
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ply increased morbidity and could harm oncologic diagnosis and treatment. Perforator flaps in the past decade have enhanced tissue recruitment and flap mobility, and in this sense, our anterior intercostal artery perforator flap can be considered an evolution of Ribeiro’s flap without many tradeoffs. Vessel dissection in fact provides superior mobility compared with the classic Ribeiro flap, without the need to perform skeletonization through the muscle. Even if the anterior intercostal artery perforator flap may be nourished by the fifth to eighth intercostal space perforators, our experience proved that safely harvesting a large amount of tissue by islanding the flap on only two or three perforators arising from the fifth or sixth intercostal space is possible. However, the fifth intercostal space perforators should be preferred, as the more caudal ones are more difficult to spare when the flap is advanced cranially and the inframammary fold redefined. In this case, distal flap vascularization is maintained by the vertical network of linking vessels connecting adjacent intercostal spaces. Furthermore, minor lateral branches may be cut either to increase the flap’s mobility or to improve its reshaping in a sort of round autologous implant. Finally, the advan-

Fig. 6. Photographs of patient 3 obtained (left) preoperatively and (right) 6 months postoperatively. Notice the improvement in abdominal skin laxity, with transition from convexity to concavity (lateral view).
tage of correcting at the same time upper abdominal lipodystrophy and ptosis must also be emphasized. Currently, upper abdominal tissue laxity may be addressed with several surgical strategies, such as anchor-line, reverse, or circumferential abdominoplasties.\textsuperscript{29,30} In our technique, the harvesting of abdominal tissue has two main advantages: first, it adds further projection to the reconstructed breast; and second, it induces an abdominal tissue lift, solving superior abdominal ptosis, which is often refractory to standard abdominoplasty. The viability of the flap has never been compromised because of many perforators nourishing this flap, and no major complications have been recorded. In some cases, a temporary distortion of the inframammary fold profile may be experienced, especially in cases of large tissue recruitment from the abdomen.

We never performed abdominoplasty and mastopexy with anterior intercostal artery perforator flap surgery at the same time because of the increased risk of complications and the additional

\begin{figure}
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\includegraphics[width=\textwidth]{patient1.png}
\caption{Photographs of patient 1 obtained (left) preoperatively and (right) 12 months postoperatively.}
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\includegraphics[width=\textwidth]{patient1_lateral.png}
\caption{Lateral preoperative (right) and postoperative (left) views of patient 1.}
\end{figure}
tension that would be placed on the inframammary fold. In planning the two procedures, we would perform abdominoplasty first and then, after 6 months, when the result was stable and the tension had been redistributed, breast reshaping. In our experience, the anterior intercostal artery perforator flap proved to be a safe and reliable option in bariatric mastopexy: it requires easy dissection and allows the harvesting of a large amount of tissue with a wide arc of rotation, thus overcoming the need for implant placement. Possible contraindications to this technique are large scars in the area of flap harvesting, such as from open cholecystectomy, or prior inferior pedicle breast reduction.

CONCLUSIONS

Autologous augmentation with the anterior intercostal artery perforator flap represents a valid option for breast reshaping in the massive weight loss population. The procedure can be easily standardized and is easy to perform, increases breast volume and projection, and corrects upper abdominal skin laxity usually not responsive to classic abdominoplasty procedures. Inverted-T mastopexy with the anterior intercostal artery perforator flap proved to be a very good technique for restoring breast shape and projection in postbariatric patients.

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