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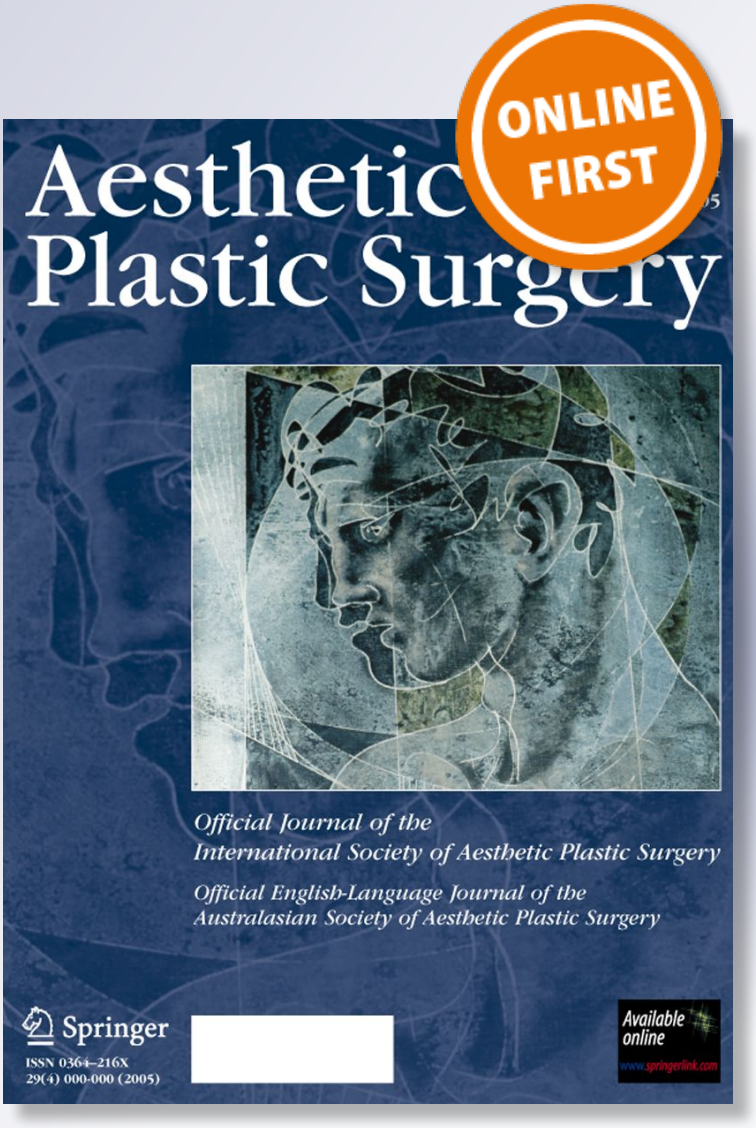

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Dynamic-Definition Male Pectoral Reshaping and Enhancement in Slim, Athletic, Obese, and Gynecomastic Patients Through Selective Fat Removal and Grafting

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Abstract
Background One of the most appealing characteristics of an athletic male body is a well-defined pectoral area. For decades, implants have been the gold standard method for the treatment of this area, but it is not suitable for every case. The goal was to design a mixed technique combining autologous fat extraction and grafting in an anatomically guided fashion to produce a highly athletic contour in the male pectoral.
Methods The patient criteria included a body mass index (BMI) lower than 30 kg/m^2, adequate skin tone, and general good health. A three-phase procedure was performed, beginning with infiltration of tumescent solution and followed by fragmentation of extra fat in an anatomic fashion using internal third-generation ultrasound; extraction that blends deep, intermediate, and superficial fat removal; and multilayer fat grafting in the pectoral area. In the presence of gynecomastia, a selective pull-through technique was used in an anatomic manner.
Results In a series of 154 consecutive male patients, the minor complications ($n = 15$) included asymmetries ($n = 10$) and residual gynecomastia ($n = 5$). The major complications ($n = 3$) included unilateral hematoma ($n = 2$), and abscess that required sonographic-guided removal ($n = 1$). An appealing muscular contour was produced in most patients, and the satisfaction rate was very high.
Conclusion Implants are no longer the only option for defining and augmenting the male chest. Combining fat grafting in a multilayer fashion with precise anatomic fat and gland removal achieved a contoured and athletic male pectoral in a safe and reproducible manner.
Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Autologous fat extraction · Fat removal · Gynecomastia · Male pectoral reshaping · Multilayer fat grafting · Liposuction · Liposculpture · Fat grafting · Ultrasound-assisted liposuction

The procedures for the male chest have been divided into three groups: pectoral implants for augmentation [8, 46, 56, 57, 64, 66, 69], fat removal for the fatty/glandular chest [1, 2, 5, 10, 29, 45, 53, 61, 70, 71], and flap surgery or combined procedures for correction of deformities [56, 77]. Gynecomastia treatments have focused on overall resection or have been combined with other procedures [1, 2, 5, 9, 10, 29, 45, 53, 61, 70, 71, 83], but often have lacked an aesthetic approach. The results have been a deflated and unattractive chest.

Implants have long been the gold standard method for treating deficiencies in the male body, most especially in the chest. Multiple types and shapes of implants have been used for pectoral augmentation including the buttocks [6, 64, 66], calf [64], and customized [6, 46, 57, 69] implants. Implants are expensive and not exempt from complications such as displacement, seromas, hematomas, capsular contracture, discomfort, infections, unnatural results, and a "female-like" appearance [6, 57, 64].

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Most of the alternatives for treating a chest deficiency are focused on correcting deformities such as Poland's syndrome, funnel chest, pectus excavatum, and gynecomastia. These treatments include flaps and liposuction.

To date, fat grafting in the body has been confined to gluteal enhancement, secondary deformities, and hand rejuvenation [8, 11–13, 16, 23–25, 30, 33, 42, 44, 49, 54, 55, 59, 60, 65, 67, 68, 80, 81, 84]. Recently, these applications have been expanded to other areas such as the deltoids and the female breast [8, 22, 25, 26, 50, 51, 62, 80, 81, 85]. The combination of fat extraction and grafting to the female breast has been used for aesthetic purposes and as an adjunctive procedure for reconstruction after lumpectomy or mastectomy with breast reconstruction [14, 26, 34, 51]. This procedure has been documented as a safe and effective technique for these types of patients [26, 30, 34, 50], although it has the potential risks of calcifications, cyst formation, infection, and misinterpretation of malignancies in mammographic studies. However, it has not been shown to modify the incidence of breast cancer [4, 8, 14, 17, 22, 26, 34, 50, 62].

The aesthetic standards for the male chest are strongly correlated with the shape and development of the pectoralis muscle. The standardization of aesthetically desirable anatomic features and the surgical approach to achieving such standards have been described by Mentz et al. [58] The technique offers a way to extract the fat around and over the pectoralis muscle to achieve definition. However, this technique cannot achieve a completely aesthetically desirable augmentation for the deficient chest; nor can it solve other problems such as gynecomastia.

Mixed techniques involving fat extraction and grafting have been reported for other regions of the body such as the gluteal area [11, 13, 15, 18, 23–25, 33, 42, 44, 59, 65, 67, 84]. Superficial liposuction has been reported to induce skin retraction, producing better results than traditional methods [27, 28, 35–41, 47, 48, 63, 76]. This principle was used as an adjunct for vibration amplification of sound energy at resonance (VASER)-assisted high-definition liposculpture (VAHDL) in the female buttocks and the male pectorals [19–21, 32, 47, 48, 52, 58, 71, 72, 74, 82, 86–88].

A method for pectoral reshaping or enhancement using deep, intermediate, and superficial liposuction is described. The described procedure follows the Avelar concept [3] in specific anatomic areas to promote skin retraction and reshaping combined with selective gland pull-through extraction and fat grafting.

Anatomy and Artistic Anatomy

The ideal male chest is defined by exposure of the surface anatomy. The aesthetic surface anatomy reflects the

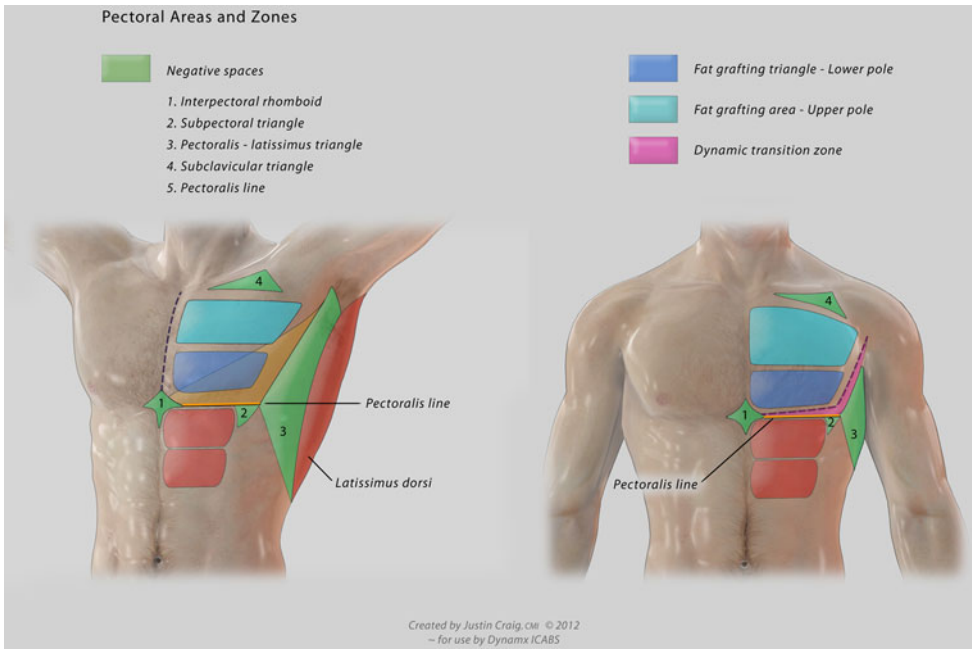

Fig. 1 Anatomic basis for the pectoral area. The aesthetically pleasing pectoral area is defined by the volume and definition of the pectoralis muscle itself. In males, it displays an *upper pole* larger than the lower pole in volume. Also, the areas of concavities or "negative spaces" (*green*) accentuate the pectoralis muscle convexity and the relationship with surrounding structures. These areas are numbered 1–5, as denoted in the text, and will be treated by extensive superficial liposuction. The yellow triangle area shows an upper limit as a line connecting the point of the internal border in the pectoralis line with the lateral insertion of the pectoralis muscle, a deep liposuction area in obese and gynecomastic patients. The dynamic-transition zone (*pink*) delimits the area of contraction versus the resting positions of the pectoralis muscle

Table 1 Treatment of the pectoral area according to body type

Body type	Deep lipo	Superficial lipo	Inframuscular fat graft	Intramuscular fat graft	Supramuscular fat graft	Open resection
Thin	+	+	+++	+++		
Athletic	+	+	+	++	+	
Fat	+++	+++	++	+++		
Gynecomastia	+	++	++	++		+

lipo liposuction

Note that a FAT patient requires an aggressive treatment in both layers and fat grafting, while the THIN patient's liposculpture is more conservative. Supramuscular fat grafting is reserved only for ATHLETIC patients as open resection is for GINECOMASTIC ones

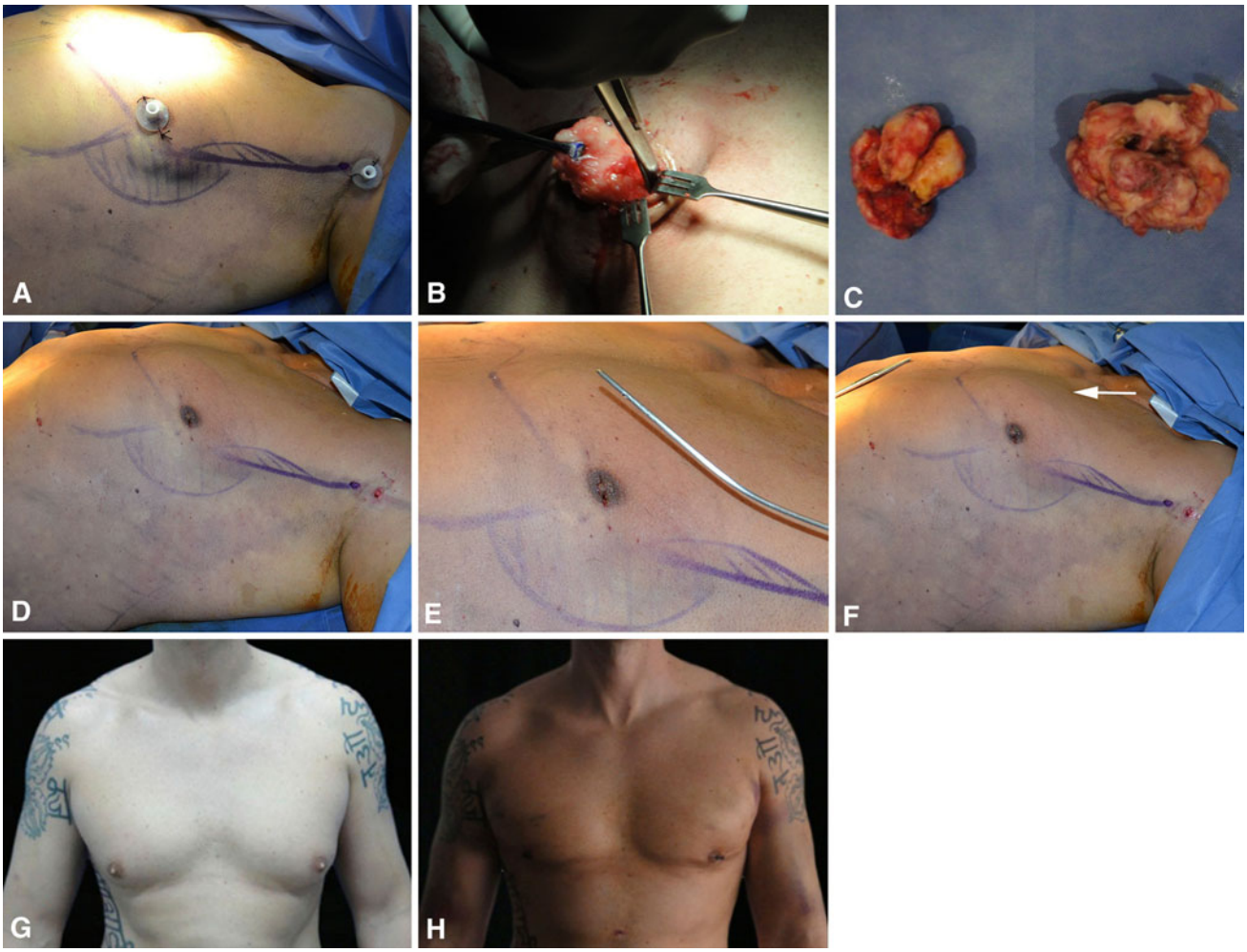

Fig. 2 Pull-through technique performed for a 44-year-old man with gynecomastia. **a** Pectoral area after deep and superficial liposuction showing a visible and marked breast disc. **b** Gynecomastia resection by pull-through with forceps in an omega incision. **c** Removed breast tissue. **d** After breast tissue resection, superficial liposuction is redone to obtain skin retraction. **e** *Upper pole* fat grafting with a curved cannula (*zoom*). **f** Immediate result after fat grafting. The *arrow* shows the increased pectoralis muscle volume. **g** Preoperative image. **h** The 48-h result. Note the desired final skin retraction and the new athletic appearance of the pectoral area. Also, the glandular appearance of the preoperative image has completely disappeared

disposition and development of the pectoralis muscle. Although it is a reflection of the muscle mass itself, the surrounding areas also must be treated to produce optimal definition.

The anatomy of the pectoral is divided into specific zones to fulfill the goals of the new technique (Fig. 1). First, the pectoralis muscle is divided into superior and inferior poles. In an aesthetically pleasing male chest, the

upper pole has a greater volume than the inferior pole due to the greater muscle mass.

The anatomic features surrounding the pectoralis muscle are divided into five "negative spaces" that are supposed to be concave to enhance the convexity of the pectoralis and the surrounding muscles (Fig. 1). The first negative space is a rhomboid between the inferior borders of the pectoralis muscle, the xiphoid process, and the origin of the rectus abdominis muscle at the midline (interpectoral rhomboid).

The second area is a triangle defined by the pectoral line and the lateral border of the rectus abdominis muscle (subpectoral triangle). This area must be treated aggressively with subdermal and intermediate liposuction [73, 75, 78]. It also links the definition of the pectoralis with the definition of the abdomen.

The third area is the triangular area between the lateral border of the pectoralis muscle and the lateral border of the latissimus dorsi muscle (pectoral-latissimus triangle). Although this is beyond the pectoral area, it is important in the contouring to expand the concavity to this limit.

The fourth area is defined as the triangular area between the subclavicular line in junction with the deltoid muscle and the upper border of the pectoralis muscle (subclavicular triangle).

The fifth and final area is a horizontal line along the inferior border of the pectoralis muscle, usually 1 cm below the nipple level (pectoralis line). This line tilts upward when the muscle is in contraction, creating another line that follows the muscular movement. The zone between these two lines is called the "dynamic transition zone." This area will be treated as a negative space that softens while it goes toward the upper pole.

Finally, there is a triangular area defined by the inferolateral border of the pectoralis muscle and an upper border of a line connecting the point of the internal border in the pectoralis line with the lateral insertion of the pectoralis muscle: Deep liposuction must be done in this area for obese and gynecomastic patients, sometimes extending to the limits of the fatty area beyond the pectoralis muscle.

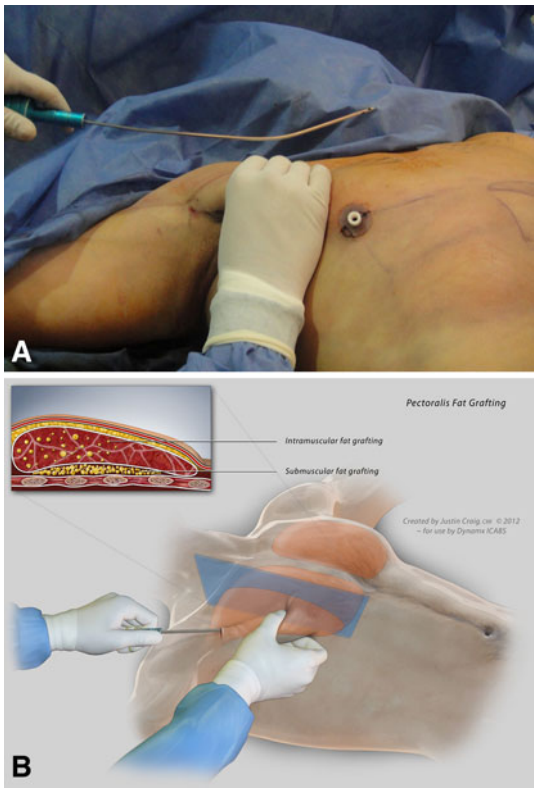

Fig. 3 Pectoral fat grafting: intraoperative image. **a** Pinch of the pectoralis muscle and fat grafting into the intramuscular layer with a 3-mm blunt curved cannula. It is important that the curvature faces upward to follow the shape of the muscle and avoid an accidental thoracic penetration. **b** Intra- and submuscular fat-grafting scheme. Most of the fat volume grafted is injected in the superior pole to enhance the muscular appearance and avoid the lower pole as much as possible

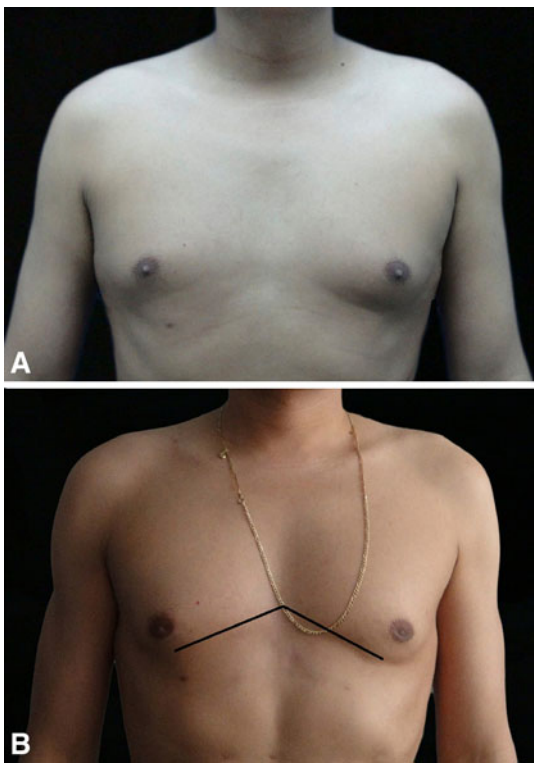

Fig. 4 Sad pectorals, defined as an oblique shape of the inferior pectoral border (**b**) in a 47-year-old man due to inaccurate preoperative markings and the presence of gynecomastia on the left side (**a**). Patients need to be evaluated carefully to draw the exact shape of the pectoral muscle in adduction of the arms, in contraction versus resting, and the presence of gynecomastia. This leads to a dynamic definition of the pectoral area

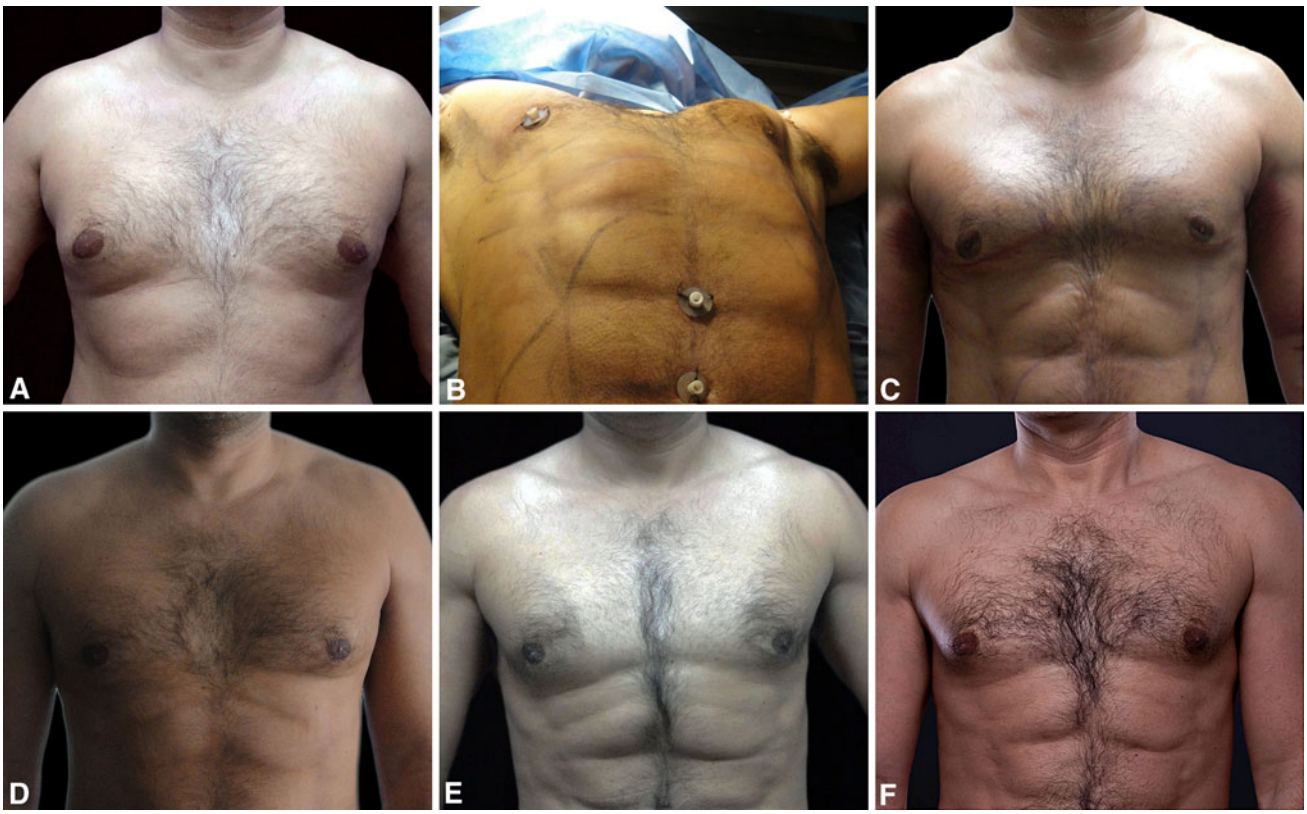

Fig. 5 Time progression of the pectoral-definition surgery performed for a 42-year-old man. **a** Preoperative view. **b** Intraoperative view. Observe the pectoral volume augmentation. **c** Postoperative 48-h result showing slight swelling and bruising. **d** Postoperative 1-week result. The bruising is disappearing, but the swelling remains due to the extensive deep liposuction in the lower pole. **e** The 6-month follow-up results. The swelling is completely absent, and the result is visible. **f** The 14-month follow-up results. The long-term and 6-month results do not differ significantly. Observe the adequate definition, the good retention of the pectoral volume, and the skin retraction

Materials and Methods

Between January 2005 and January 2012, 154 procedures for consecutive men were performed at four different surgery centers: the Santa Barbara Medical Center (81 procedures) and the Evolution Medical Center (56 procedures) in Bogotá, and the FOSCAL and Clinica Chicamocha (17 procedures) in Bucaramanga, Colombia. Third-generation ultrasound assisted 136 of these procedures [47, 48], and in 57 procedures, fat grafting was performed. The patients ranged in age from 18 to 62 years.

All the patients underwent routine preoperative lab tests including hemoglobin, hematocrit, prothrombin time, thromboplastin time, serum creatinine, and urea. Patients older than 40 years were required to have an electrocardiogram (ECG) and a cardiac evaluation. Patients selected for the procedure had a body mass index (BMI) lower than 30 kg/m^2. Those with a marked laxity of skin were excluded from the study.

The patients were divided into four groups according to body type (thin, athletic, fat, and gynecomastia), leading to different choices of procedure. For the thin patients (type 1), definition via superficial liposuction was performed as an adjunct to fat grafting in the muscular and submuscular layers.

For the athletic patients (type 2), definition was done by deep and superficial liposuction. These patients seldom required fat grafting, but some of them required supramuscular fat grafting. This is possible in athletic patients due to the lack of extensive deep liposuction (in contrast to the other types), diminishing the chance of fat migration due to tunneling in the supramuscular layer.

For the fat patients (type 3) or pseudogynecomastia patients, liposuction was performed to remove the whole deep fat tissue in and around the pectoralis area and superficial fat to achieve skin retraction of the area. Also, fat grafting to the upper pole was performed to replace the volume extracted in the lower pole, giving a lifted appearance.

Finally, for patients with true gynecomastia (type 4), open resection by an omega incision was added to the protocol for the fat body type group (Table 1). Body

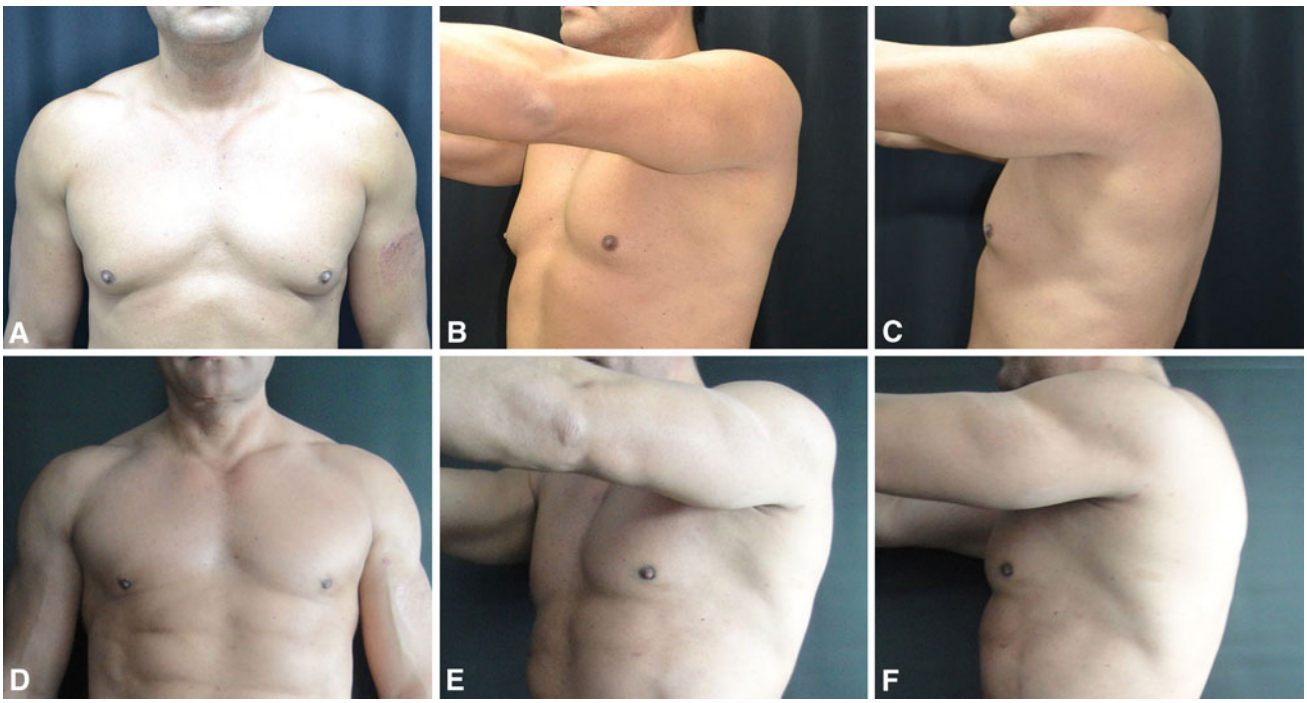

Fig. 6 A 47-year-old man with gynecomastia who underwent dynamic-definition pectoral reshaping and fat grafting with gynecomastia resection by the pull-through technique. Trunk and arm liposculpture was performed at the same time. **a–c** Preoperative anterior, oblique, and lateral images. **d–f** Postoperative images at 3 months. Note the newly defined muscular appearance of the pectoral area and the dynamic definition in which pectoral muscle contraction leads to an athletic look

contouring on other parts of the anatomy also was performed routinely.

During surgery, all the patients received 2 g of cefazolin, 8 mg of dexametasone, 8 mg of ondansetron, 75 mg of diclofenac, and 50 mg of tramadol. For all the patients, chest photos were taken, with anterior, oblique, and lateral views before and after the procedure. Chest magnetic resonance imaging (MRI) was performed for two patients before the procedure, then 2 and 6 months afterward, with the aim to evaluate only the multilayer (sub- and intramuscular) location and retention of the fat graft.

Surgical Technique

Marking. With the patient standing, we first mark fat deposits for removal with deep liposculpture. For deep removal, a triangular area between the inferolateral border of the pectoralis muscle and the line between the inner border of the muscle and the lateral insertion of the muscle is marked (Fig. 1, yellow triangle). We also mark depressions or areas that need more projection in the pectoralis, especially the upper pole, for treatment with fat grafting.

After the conventional markings, the surface anatomy is marked in the areas of superficial liposculpture. The pectoralis muscle is marked with the patient in a resting and contraction position to demarcate the dynamic transition zone. It is very important to induce contraction with the arms down for accuracy.

The negative spaces are marked as well including the pectoral-latissimus triangle, the inferior pectoral triangle, the pectoral line, the interpectoral rhomboid, and the subclavicular triangle (Fig. 1, green areas). In patients with gynecomastia, the entire gland bud is marked, and its area beyond the pectoralis muscle limits is marked for selective extraction by the pull-through technique (Fig. 2).

Deep Layer Lipoplasty

With the patient under general anesthesia, we proceed to infiltrate using tumescent solution comprising 1,000 ml of normal saline, 50 ml of 1 % lidocaine, and 1 ampule of epinephrine 1:1.000. Third-generation ultrasound-assisted lipoplasty is performed. The ratio of infiltration and volume of fat removed is approximately 2:1. We use VASER in 80 % continuous mode for deep fat fragmentation with a 2.9- or 3.7-mm two-ring probe (Sound Surgical Technologies, Denver, CO, USA). The aspiration of fat includes the subpectoral area, the triangular pectoral area (yellow triangle in Fig. 1), the triangular area lateral to

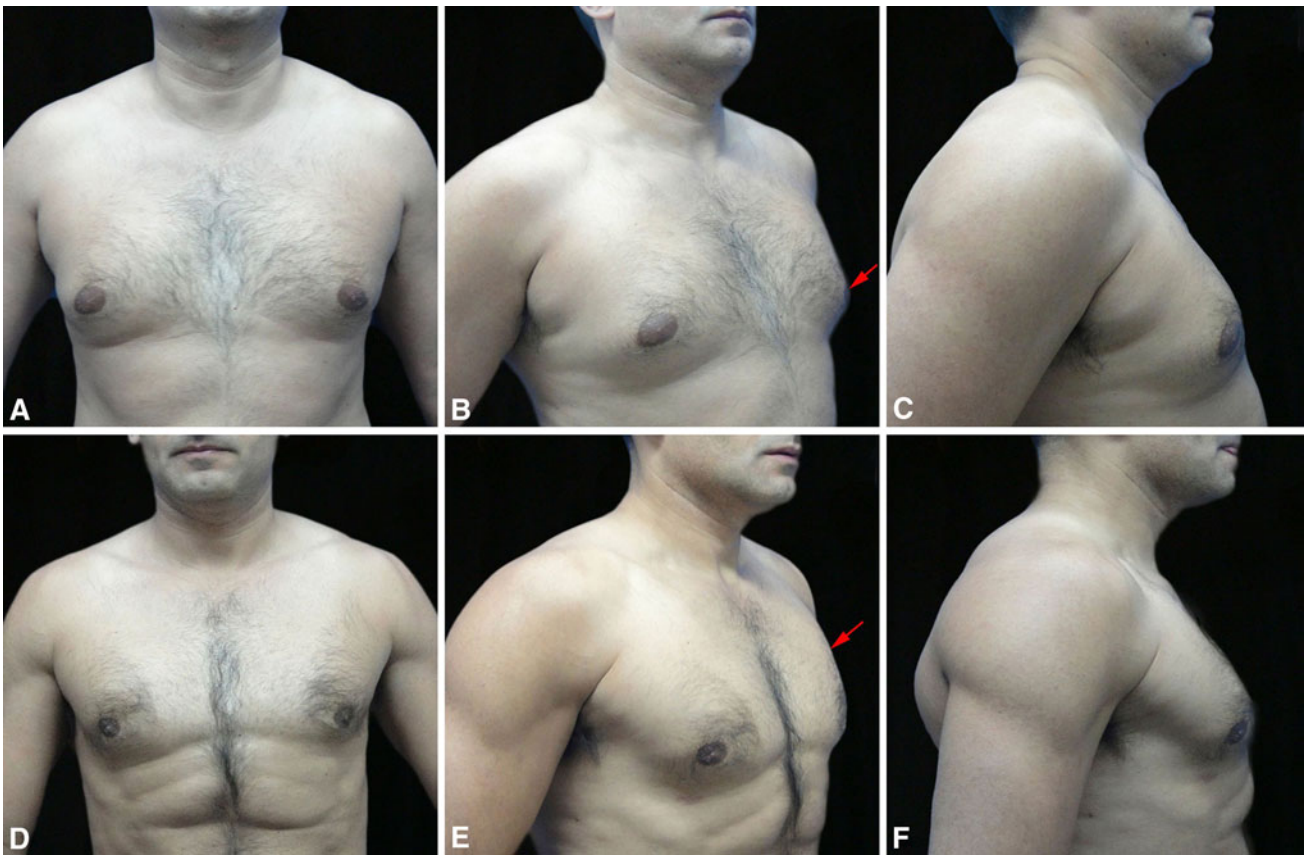

Fig. 7 Fat patient: A 42-year-old man with pseudogynecomastia who underwent the reported procedure. Arm and trunk liposculpture also were performed at the same time. **a–c** Preoperative anterior, oblique, and lateral views. **d–f** Postoperative views at 6 months. Observe the change from a glandular to an athletic shape. The *arrows* show the volumetric switch from the lower pole to the *upper pole*

the muscle, and the axillary fat pad over the superior lateral border of the pectoral beneath the claviculae and the deltoid muscle.

Superficial Lipoplasty

In the superficial layer, aspiration is used to sculpt the horizontal line inferior to the pectoralis muscle. It is important to notice the position of the arms on the operating table while this line is carved. The arms must be adducted in contact with the body. If they are abducted, sculpture here can lead to an angled line ("sad pectorals," Fig. 4) instead of a straight line in the final result. Here, VASER is used in 80 % pulsed mode with a 2.9-mm probe (Sound Surgical Technologies). Subdermal liposuction is performed in negative-space areas as the triangle lateral to the pectoralis and the inferior squared area in the junction of the inferior pectoralis and the lateral rectus abdominis muscle. This serves to define the rectus as well. This is performed using Vent X cannulas (Sound Surgical Technologies).

Intermediate Lipoplasty

The junction between the superficial and the deep zones is blended to produce a defined border of the pectoralis muscle (lateral and inferior). Also, the subclavicular triangle is treated.

Pull-Through Technique [9, 45, 61, 70]

For patients with true gynecomastia (glandular tissue), an omega-shaped incision is made around the nipple. We cut the glandular breast disc into quadrants for easier dissection and removal. The superficial bud then is removed completely (Fig. 2). Additional superficial liposuction can be performed to gain skin retraction.

Fat Grafting

Fat tissue is harvested with a 3-mm blunt cannula from other areas of the body to an empty, sterile bottle trap. To the trap is added 1 g of cefazoline. Decantation is the only

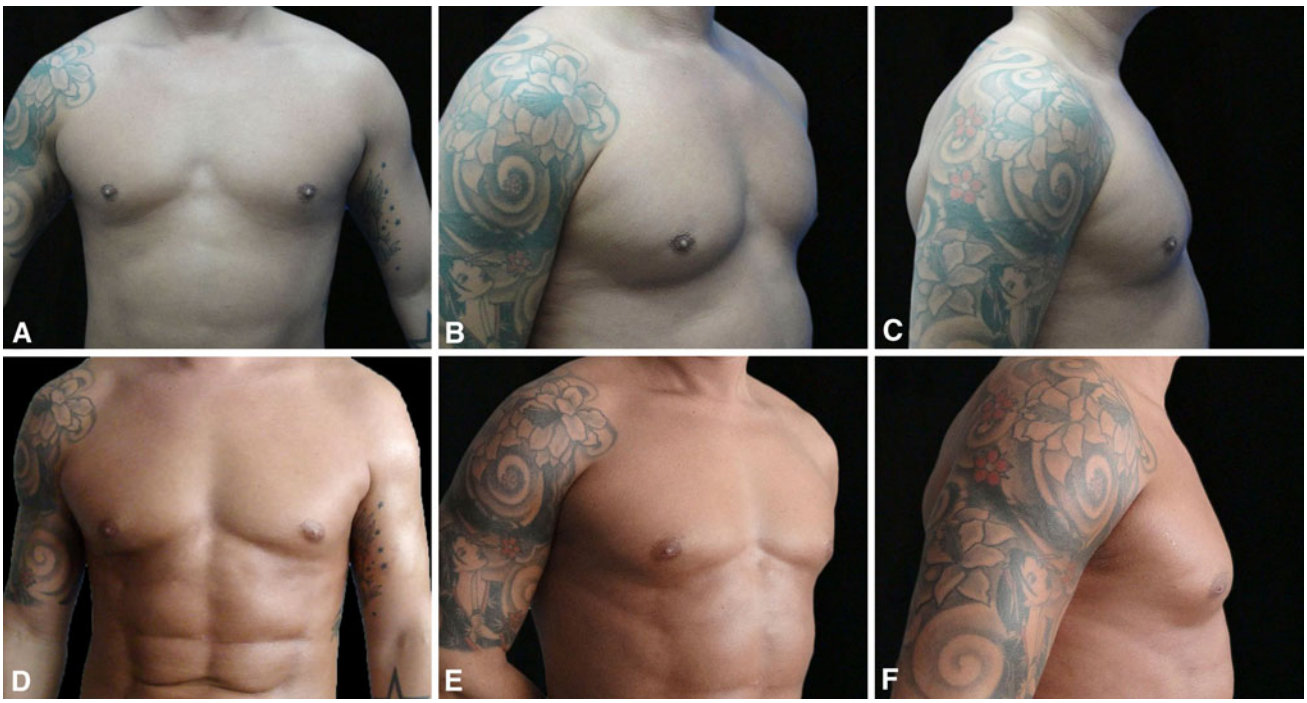

Fig. 8 Athletic patient: A 40-year-old man with glandular appearance of the pectoral zone who underwent dynamic-definition pectoral reshaping. **a–c** Preoperative views. **d–f** Postoperative views at 5 months. Note the pectorals' new "brawny" look, enhancing the underlying muscular structure by taking advantage of the skin retraction

process used to separate the fat cells from the saline and serosanguineous components. Through the anterior axillary fold incision, the pectoralis major is located and pinched for insertion of a 3-mm blunt 30° curved cannula into the intramuscular layer (Fig. 3). This curvature is important because it follows the muscle shape, allowing secure performance of the graft and avoiding any risk for thoracic penetration. Most of the volume of intra- and submuscular fat is grafted into the superior pole to enhance the muscular appearance. We avoid grafting to the inferior pole to steer clear of a "glandular" appearance. The average total fat injection is 150 ml (range, 70–300 ml) on each side.

Results

In a series of 154 consecutive male patients, only three major complications were reported (2 %), all of them secondary to the procedure. One abscess was resolved with antibiotics (ampicillin/sulbactam 375 mg administered orally three times daily for 10 days) and sonographic-guided puncture for extraction. Two hematomas were resolved by manual drainage through the open nipple incision.

The minor complications included complaints of asymmetry by 15 patients (9.7 %), residual skin laxity by 4 patients (2.6 %), low definition by 4 patients (2.6 %) who could undergo a new "refinement procedure," and oblique shape of the inferior pectoral border ("sad pectorals," Fig. 4) by 5 patients (3.2 %). This oblique shape was caused by the muscle anatomy. In two cases, the "sad pectorals" were due to the presence of gynecomastia undiagnosed in the preoperative evaluation.

The combined multilamellar lipoplasty resulted in very athletic results for most patients (Figs. 5, 6, 7, 8, 9). The satisfaction index was measured by a survey of all the patients ($n = 136$) 6 months after surgery as follows: 1 (poor results), 2 (below expectations), 3 (average), 4 (good results), 5 (above expectations). The results showed the following ratings: above expectations (84.6 %, $n = 115$), good results (9.6 %, $n = 13$), average (5.1 %, $n = 7$). Only one patient (0.7 %) complained about bad results. When the "good results" and the "above expectations" values are summed, the above average satisfaction rate is 94.2 %.

Discussion

To date, the only option for achieving a fully shaped male chest has been pectoral implants. Implants required proper morbidity and led to complications and patient dissatisfaction because of chronic pain, discomfort in exercise, visible scars, deformities, and prosthesis migration. With our new procedure, we have achieved aesthetically

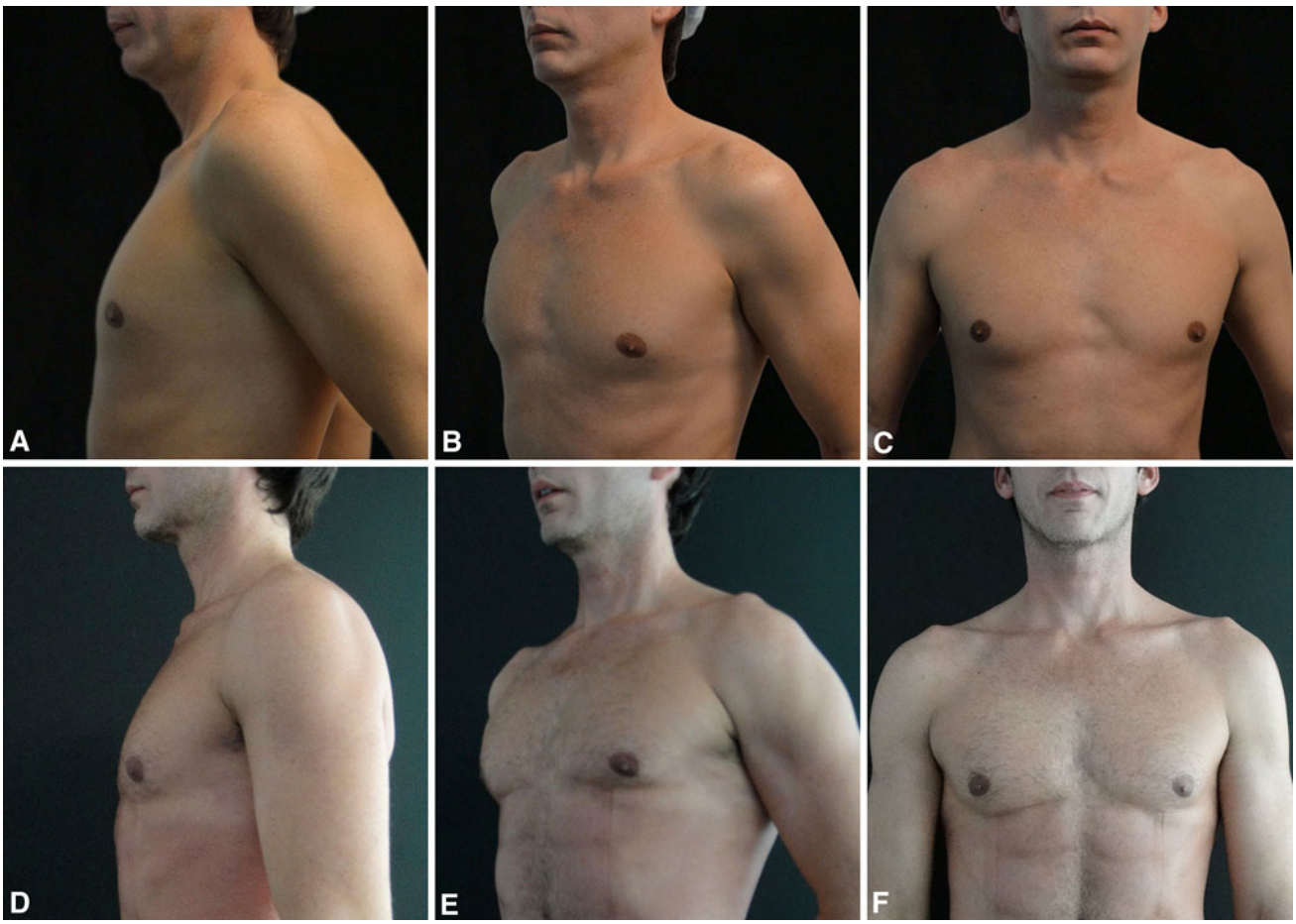

Fig. 9 Thin patient: A 39-year-old man who underwent dynamic-definition pectoral reshaping and enhancement with fat grafting. **a–c** Presurgical photos. **d–f** Postsurgical photos at 2 months. Trunk and arm liposculpture also was performed. Notice the incremented volume of the *upper pole* in the pectoralis muscle. In addition, a kind of asymmetry can be observed because of the underlying previous muscle shape

pleasing results with minor scarring, fewer complications, faster patient recovery, no pain in exercise or daily life, and a very high satisfaction rate.

This procedure for male pectoral correction and enhancement was performed using high-definition lipoplasty in other areas as part of the procedure [47, 48]. This technique that combines superficial, intermediate, and deep lipoplasty with fat grafting to reproduce the superficial anatomy has been performed for more than 7 years. It has required a long learning curve to reproduce a natural athletic appearance. Some early patients had less than optimal results due to poor presurgical marking, such as marking patients with the arms up, and due to low fat extraction in the lateral triangle or in the inferior border of the pectoralis muscle. Also, the underdiagnosis of gynecomastia has led to mistreatment of the area.

The division in the upper and lower poles of the pectoralis muscle created a guide to change the pectoralis shape and augmentation. In addition, the description of the "negative space" areas set a guideline to generate better and reproducible results in every patient.

To date, gynecomastia management has been complicated because of its visual results and multiple residual deformities. As a result, many men with this disease fear surgical procedures. On the other hand, the pull-through technique combined with dynamic-definition liposuction and fat grafting promote much better results in this group of patients, not only by solving their base problem, but also by enhancing the pectoral to achieve an aesthetic result.

We realize that new techniques require time to be accepted in the medical community. Nonetheless, we have presented a viable option for producing a well-defined and natural male chest. Intense training and expert assessment are required to obtain the perfect reproduction. However, when achieved, the reproduction of a natural athletic chest is superior to the result achieved by implants in every way.

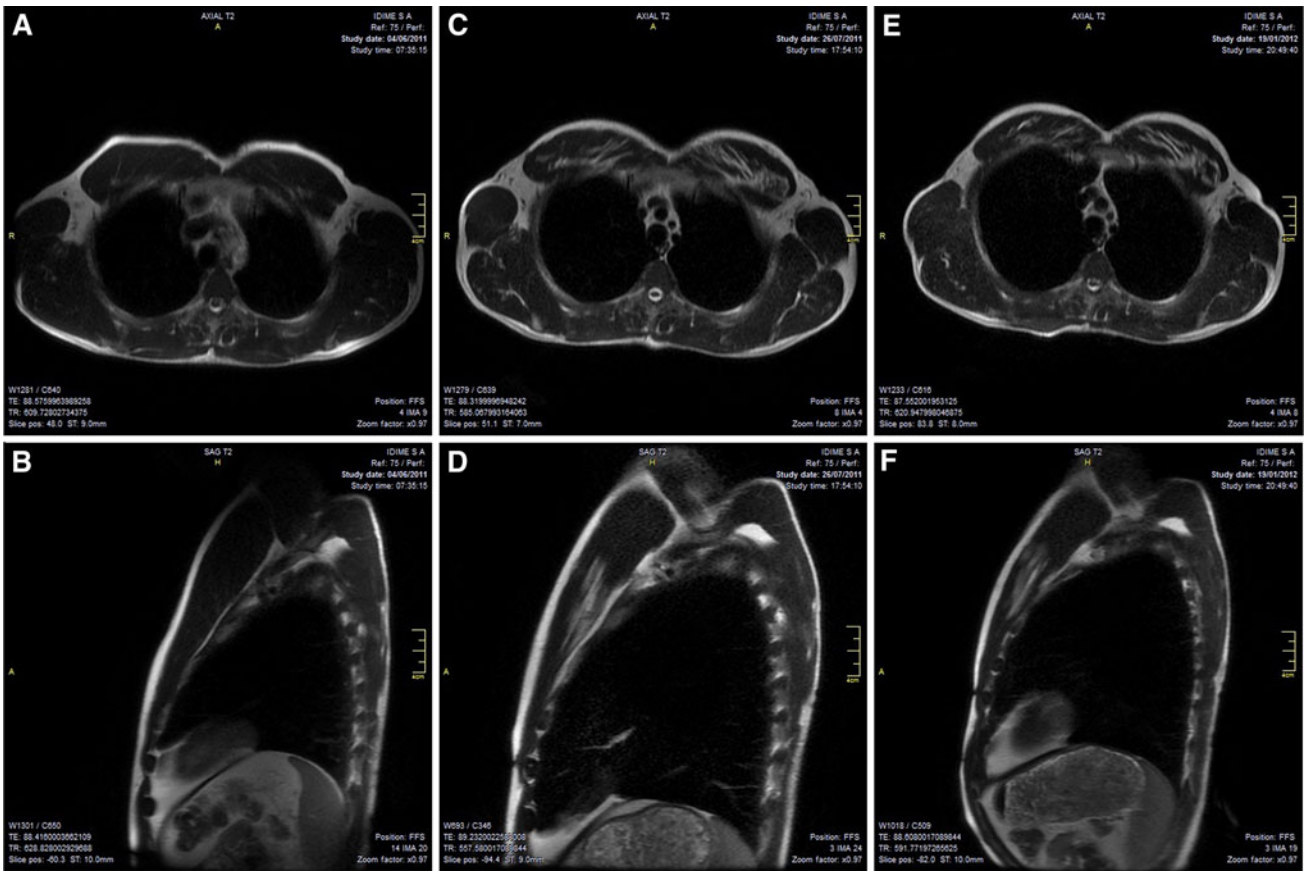

Fig. 10 Chest magnetic resonance imaging (MRI): Report from a 42-year-old man who underwent dynamic-definition pectoral reshaping with fat grafting. In each pectoral zone, 200 ml of autologous fat was grafted in the sub- and intramuscular layers. **a**, **b** View before the procedure. **c**, **d** View 2 months after the procedure. **e**, **f** View 6 months after the procedure. The later reported a fat retention of 169 ml from the initial 200 ml lipoinjected into the right pectoral and 189 ml from the 200 ml lipoinjected into the left pectoral. Between the 2- and 6-month MRIs, a minimum decrease in the submuscular fat retention was reported

Keeping premises in fat grafting in mind, we realized that the intramuscular layer itself allows no more than 100 ml of fat because of the limited muscular volume. However, by using a multilayer approach, we were able to take advantage of the receptiveness of the other layers. The muscle mass present determines the amount of fat grafted to the intramuscular layer.

Although the medical literature finds the follow-up period in fat grafting controversial [7, 12, 16, 25, 30, 31, 43, 51, 55, 79, 82], recent studies report minor changes after 6 months [40, 76, 82]. However, we consider that further studies must be conducted to get a standard timing for fat survival follow-up evaluation. For two patients in whom chest MRI was performed, the 6-month follow-up evaluation reported 169 ml from the initial 200-ml lipoinjection in the right pectoral and 189 ml from the 200-ml lipoinjection in the left pectoral. Comparing 2- and 6-month MRIs shows a good fat retention in the muscular layer and a small decrease in the submuscular layer (Fig. 10).

Conclusions

Combined fat grafting and extraction is an effective, inexpensive, and time-efficient alternative to implants or liposuction alone for the male chest. It is a safe procedure with highly defined, reproducible results. It is best performed in tandem with dynamic-definition lipoplasty, a liposculpture that can reproduce the anatomic landmarks of an athletic body.

The use of third-generation ultrasound facilitated the fat extraction, increased the volume of aspirated fat permitted per patient, ensured adequate results in the superficial-layer liposculpture, and minimized the postoperative pain and bruising common with earlier procedures.

We could infer that fat grafting and dynamic-definition pectoral reshaping are a better option for those who want to appear more natural than implants due to a faster operation, minimized postoperative recovery time, and minimal scarring. It produced a very natural result that allowed patients to resume their normal lifestyle even faster than

traditional approaches with implants. The change in treatment for a fat or gynecomastia patient from merely flattening of the area to volumetric transposition from the lower to the upper pole led to highly satisfactory results, proposing a paradigm shift in the treatment of these problems.

By the rate of complications reported, we conclude that this new procedure is safe and reproducible at any time anywhere. Any well-trained plastic surgeon who has the correct knowledge of this procedure can perform it and obtain the described results.

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