# Stromal-Enriched Lipograft™: Combining Chemical Automatic Cell Station and Mechanical Lipocube for Supercharged Fat Graft

11

Aris Sterodimas

## Contents



## 11.1 Introduction

The improvement of surgical techniques in autologous fat transplantation has increased the survival rate of the grafted fat and has reduced the side effects such as fat necrosis. Several mechanisms may contribute to the variability of outcomes for fat-grafting procedures. The harvesting process is traumatic to adipocytes, which can lead to apoptosis. Additionally, results for recipient wound beds with different degrees of blood supply and fluctuations in oxygen delivery may range from adequate revascularization and good "take" to insufficient revascularization and ischemia, apoptosis, and dedifferentiation of central adipocytes [1]. A significant proportion of the engrafted fat undergoes resorption and necrosis due to the non-vascularized nature of the transplant. Resorption rates after fat grafting are generally reported to be between 55 and 80% [2]. Therefore, in order to maximize survival, multiple passes in different tissue planes are required in order to optimize plasmatic imbibition and neovascularization of the transplanted fat grafts. Injection of the fat graft should be met with minimal resistance, and a small volume should be administered upon entry, with the remaining volume given during withdrawal to minimize trauma. Adipose tissue is composed of mature adipocytes constituting about 90% of the tissue volume and a stromal vascular fraction (SVF), including fibroblasts, endothelial cells, preadipocytes, vascular smooth muscle cells, lymphocytes, and resident monocytes/macrophages. It has become apparent over the years that white adipose tissue (WAT) is the most suitable autologous injectable filler for correcting soft tissue defects [3]. Adipose tissue is considered as a source of mesenchymal stem cells (MSCs), termed adipose-derived stem cells (ADSCs). They are ubiquitous and easily obtained in large quantities with little donor site morbidity or patient discomfort, making the use of autologous ADSCs an appropriate cellular therapy. The use of ADSCs may enhance angiogenesis, improve the survival of grafts, and thus reduce the atrophy of the fat grafting [4]. ADSCs have been evaluated in clinical studies for soft tissue augmentation and represent a novel approach to cell-based therapies, such as autologous fat transplantation. Nowadays, autologous fat transplantation or adipose cell grafting incorporates adipocytes, ADSCs, and growth factors already present in the lipoaspirate. In 2005, the research team led by the senior author Dr. Sterodimas described a method of supplementing the lipoaspirate used for fat grafting with the stromal vascular fraction found in adipose. This process was named Stromal-Enriched Lipograft™. The Stromal-Enriched Lipograft™ (SEL™) is a surgical technique of autologous fat grafting for face and body contouring that converts a stem cell-poor fat graft to a

A. Sterodimas (✉)
Plastic & Reconstructive Surgery Department, Metropolitan General Hospital, Athens, Greece
e-mail: aris@sterodimas.com; https://www.sterodimas.com



A. Di Giuseppe et al. (eds.), *Fat Transfer in Plastic Surgery*, https://doi.org/10.1007/978-3-031-10881-5_11

stem cell-rich fat graft [5]. The clinical outcomes of scientific research on the last decade have shown that SEL is one of the core elements of regenerative medicine.

## 11.2 Patient Selection

Contouring of the face, breast, trunk, and extremities combine liposuction, excisional surgical techniques, and autologous fat grafting [6]. These patients should be carefully evaluated for their expectations and the actual results that can be achieved by the proposed procedures. Planning each procedure and indicating it properly is just as important as the surgical procedure itself. The ideal patient has a small amount of adipose tissue to be suctioned out in order to improve the face and body contour, has small skin laxity, and is dedicated to a healthy lifestyle, including daily physical exercise and a healthy diet. It is the responsibility of the surgeon to address all concerns, risks, goals and expectations of the procedure chosen to the patient in order to avoid false expectations and future frustrations. In this chapter, we will address special attention to fat grafting of the face, breast, upper and lower abdomen, upper and lower back, flanks, pubis and sacrum V-zone, gluteal area, inner thighs, outer thighs, inner knees, and hands.

## 11.3 Technique

Marking of the areas to be liposucted is made while the patient is in a standing position. Preoperative sedation in the surgical suite is administered. Anesthesia consists of an epidural block and intravenous sedation. The patient is placed in a prone position. After the injection of normal saline wetting solution containing 1:500,000 of adrenaline by a small bore cannula and waiting 15 min, a 60-cc syringe attached to a 4 mm blunt cannula is inserted through small incisions. Fat is aspirated by using the syringe method. Two-third of the aspirated fat is used in order to isolate the SVF. Digestion is done with 0.075% collagenase (Sigma, St. Louis, MO) in buffered saline and agitated for 30 minutes at 37°C in Automatic Cell Station (ACS) manufactured by BSL in Seoul, S. Korea. Separation of the SVF containing ADSCs is then done by using centrifugation at 1200 × *g* for 5 min using the ACS. The SVF is located in the pellet derived from the centrifuged fat at the bottom of the lipoaspirate. In Stromal-Enriched Lipograft (SEL), freshly isolated SVF is attached to the aspirated fat, with the fat tissue acting as a living bioscaffold before transplantation [7]. The remaining 1/3 of the aspirated fat is treated as follows: with the syringe held vertically with the open end down, the fat and fluid are separated. Isotonic saline is added to the syringe, the fat and saline are separated, and the exudate is discarded. The procedure is repeated until the fat becomes yellow in color, free of blood, and other contaminants [8]. Mixing of the SVF containing ADSCs and the purified fat is then done (Fig. 11.1). This whole procedure is done inside the operating theater by two tissue engineers, manually, and the time required is about 90 min (Video 11.1). The Lipocube™ is a single-use mechanical device for processing lipoaspirate, the Stromal-Enriched Lipograft™, into milli, micro, and nano fat graft according to the depth of transfer (Fig. 11.2). The device processes fat tissue in a closed sterile system with specific structural geometry blades coupled with a flow pattern enabling partial filtration of fibrous material. Tissue planes are created by using specific cannulas in different trajectories, always from the deeper aspect to more superficial areas using the MAFT-GUN produced by Dermato Plastica Beauty Co, Ltd. in Taiwan. Successful fat application is performed using a blunt cannula that creates a tunnel at insertion, and the fat is injected as the cannula is withdrawn in order to avoid intravascular fat injection. Multiple passes are used to fan across the deficient region. Antibiotics, analgesics, and anti-inflammatory medications are prescribed during the following 7 postoperative days.

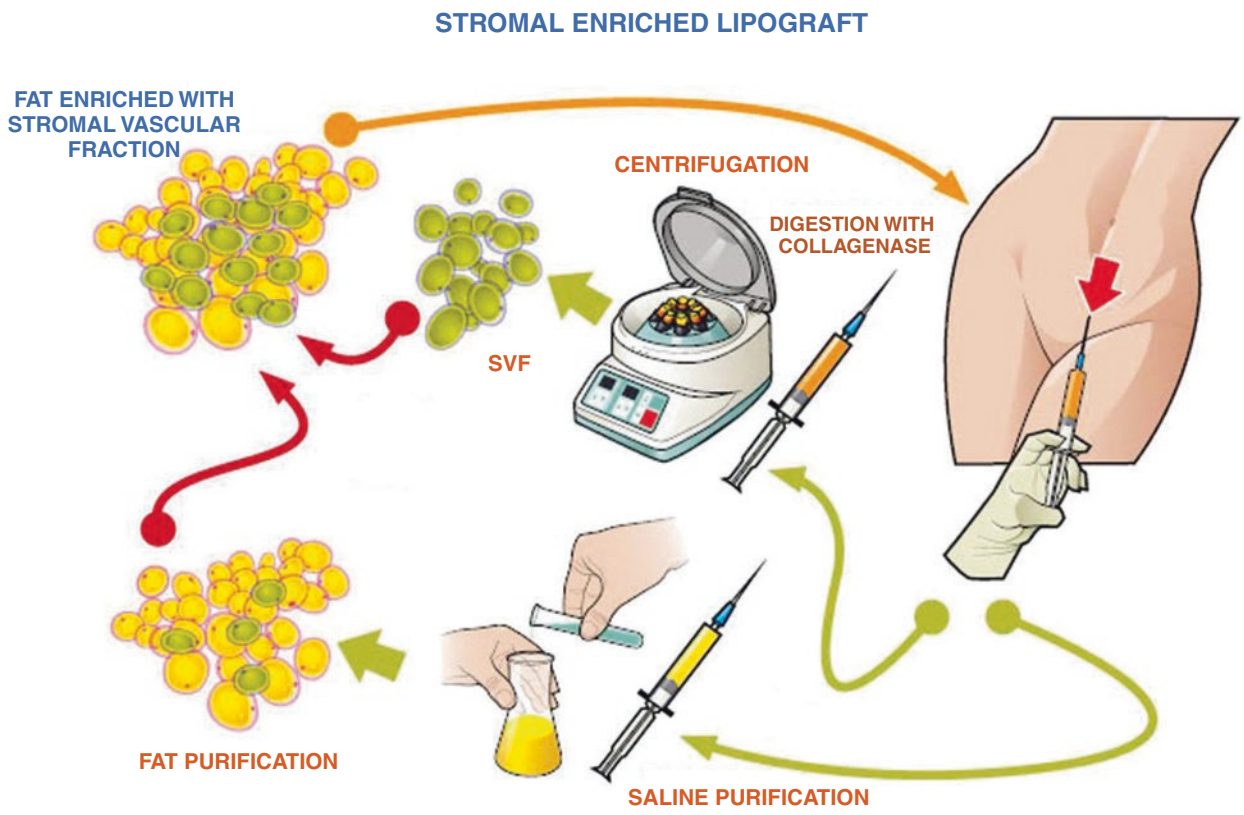


**Fig. 11.1** Schematic representation of Stromal Enriched Lipograft technique

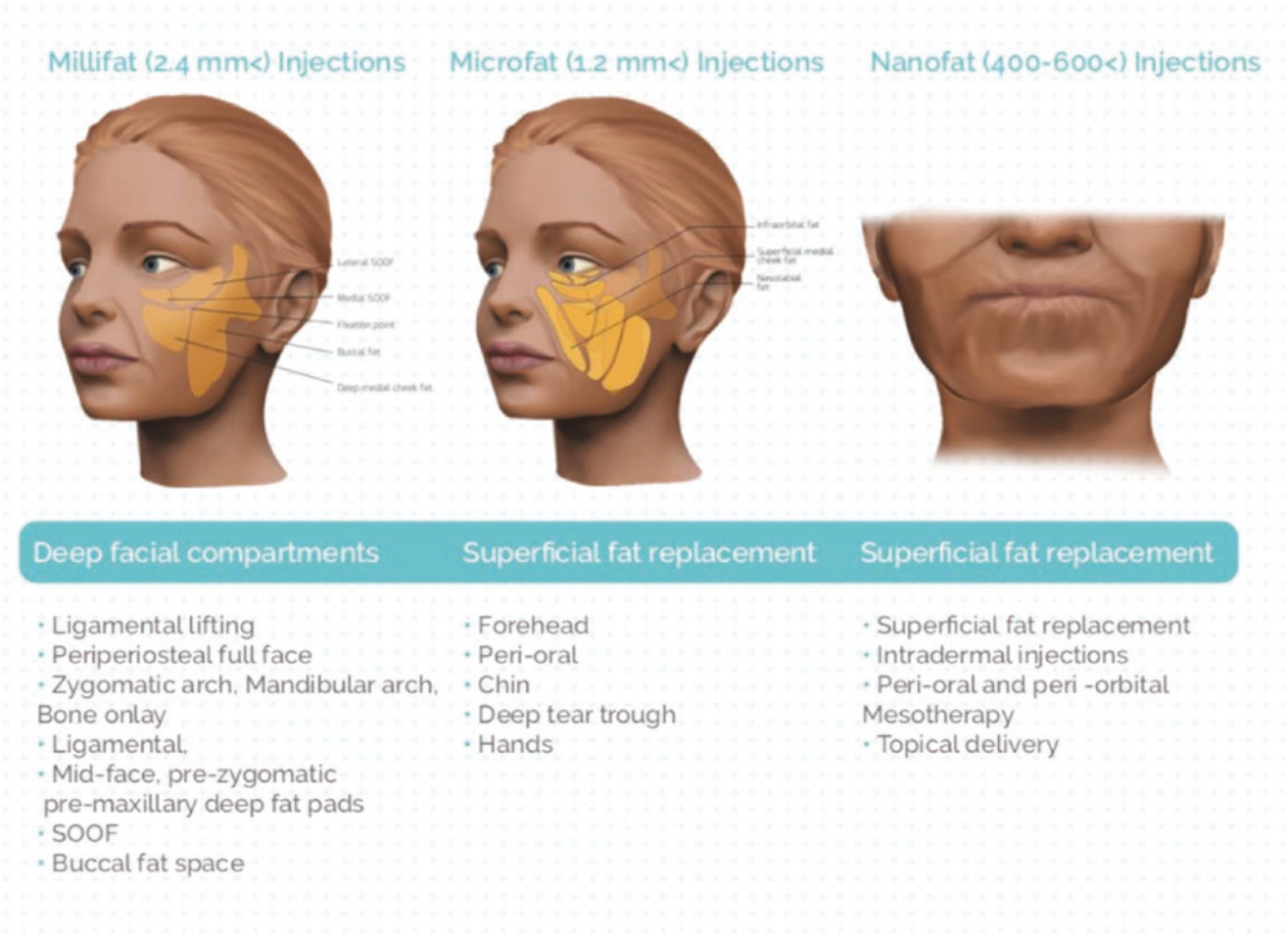


**Fig. 11.2** A Schematic representation of the different fat products (millifat, microfat and nanofat) for facial rejuvenation

## 11.4 Clinical Applications

Stromal-Enriched Lipograft technique aims at filling preoperatively marked deficiencies with adipocytes that will survive and become incorporated into the recipient bed. The combination of circumferential liposuction, SEL of breasts, buttocks, and lower limbs in a single surgical procedure has been performed successfully in the last 10 years, emphasizing the low rate of complications and the high overall patient satisfaction [9]. The procedure is named All-in-One™. SEL™ should be thought as part of body contouring in order to give the balanced and properly proportioned anatomy of the body. The aspirated fat may be utilized to augment, shape, and to correct irregularities or asymmetry that may be detected preoperatively [10]. The use of Stromal-Enriched Lipograft for body contouring has gained attention due to further improvements in fat preparation and processing. Recently the concept of composite body contouring has been introduced, combining lipoabdominoplasty and Stromal-Enriched Lipograft to the thighs and gluteal area has been done in 575 patients with aesthetically favorable results.

### 11.4.1 Patient 1

This 49-year-old lady presented complaining of facial sagging, which made her "unattractive." Preoperative views of the patient are shown in Fig. 11.3a–c. Face lifting assisted by SEL was performed. The total fat transfer is 30 mL. Postoperative views were taken 2 years after the procedure (Fig. 11.3d–f).

### 11.4.2 Patient 2

This 63-year-old lady presented complaining of facial sagging, which made her "unattractive." Preoperative views of the patient are shown in Fig. 11.4a–c. Face lifting assisted by SEL was performed. The total fat transfer is 30 mL. Postoperative views were taken 2 years after the procedure. Postoperative views were taken 1 year after the procedure (Fig. 11.4d–f).


**Fig. 11.3** (**a**–**c**) Preoperative views of a 47-year-old lady presented complaining of facial atrophy and flaccidity. (**d**–**f**) Postoperative views of a 47-year-old lady 2 years after face lifting assisted by SEL was performed


**Fig. 11.3** (continued)

### 11.4.3 Patient 3

This 22-year-old lady presented complaining of breast hypomastia, which made her "unattractive". Preoperative views of the patient are shown in Fig. 11.5a–c. Liposuction of the back, flanks, and abdomen and SEL was performed in both breasts. The fat transfer per breast was 190 mL in the first session. Postoperative views were taken 2 years after the procedure (Fig. 11.5d–f). The patient decided that she wanted to have another SEL session 3 years after the initial operation. She underwent liposuction of the back, flanks, and abdomen and SEL was performed in both breasts. The fat transfer per breast was 250 mL in the second session. Postoperative views were taken 1 year after the second procedure (Fig. 11.5g–i).

### 11.4.4 Patient 4

This 28-year-old woman presented for liposuction and moderate buttock enhancement. Preoperative views of the patient are shown in Fig. 11.6a, b. Liposuction of the back, flanks, and abdomen was done. Stromal-Enriched Lipograft was performed. The total buttocks fat transfer was 350 mL per side. Postoperative views were taken 3 years after the procedure (Fig. 11.6c, d).

### 11.4.5 Patient 5

This 35-year-old man complained about his body shape. Preoperative views of the patient are shown in Fig. 11.7a–c. Liposuction of the back, flanks, chest, and abdomen and SEL was performed. The total gluteal fat transfer was 270 mL per side using the SEL technique. Postoperative views were taken 2 years after the procedure (Fig. 11.7d–f).

### 11.4.6 Patient 6

This 51-year-old lady presented, complaining of having excess skin and fat deposits, which made her "unattractive." Preoperative views are shown in Fig. 11.8a–c. Liposuction of the back, flanks, lipoabdominoplasty, and SEL was performed. The total gluteal fat transfer was 420 mL per side


**Fig. 11.4** (**a**–**c**) Preoperative views of a 63-year-old woman 2 years after face lifting assisted by SEL was performed. (**d**–**f**) Postoperative views of a 47-year-old lady 2 years after face lifting assisted by SEL was performed


**Fig. 11.4** (continued)

using the SEL technique. Postoperative views were taken 4 years after the procedure (Fig. 11.8e–g).

### 11.4.7 Patient 7

This 73-year-old woman presented, complaining of her "unattractive" hands. Preoperative views are shown in Fig. 11.9a. Liposuction of the back, flanks, and SEL of the hands was performed. The total fat transfer to each hand was 12 mL using the SEL technique. Postoperative views taken 2 years after the procedure (Fig. 11.9b).

### 11.4.8 Patient 8

This 42-year-old woman presented requesting rejuvenation of her external genitalia. Preoperative views are shown in Fig. 11.10a. Liposuction of the back, flanks, and SEL of the external genitalia was performed. The total fat transfer to the external genitalia was 32 mL using the SEL technique. Postoperative views were taken 1 year after the procedure (Fig. 11.10b).

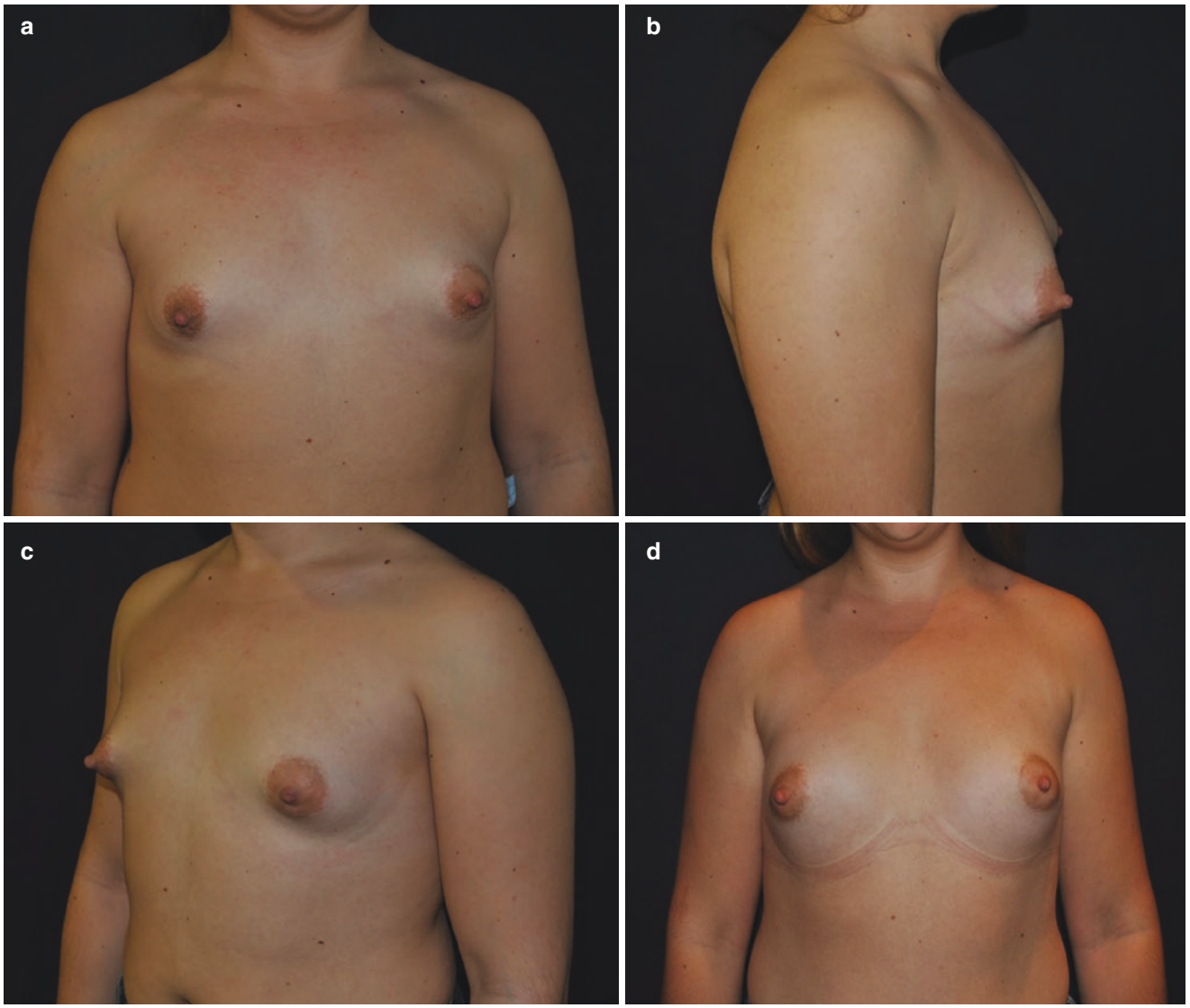


**Fig. 11.5** (**a**–**c**) Preoperative views of a 22-year old female patient with hypomastia. (**d**–**f**) Postoperative views of a 22-year old female patient after breast SEL 2 years after the first surgical intervention. (**g**–**i**) Postoperative views of a 22-year old female patient 1 year after the second surgical intervention for breast SEL

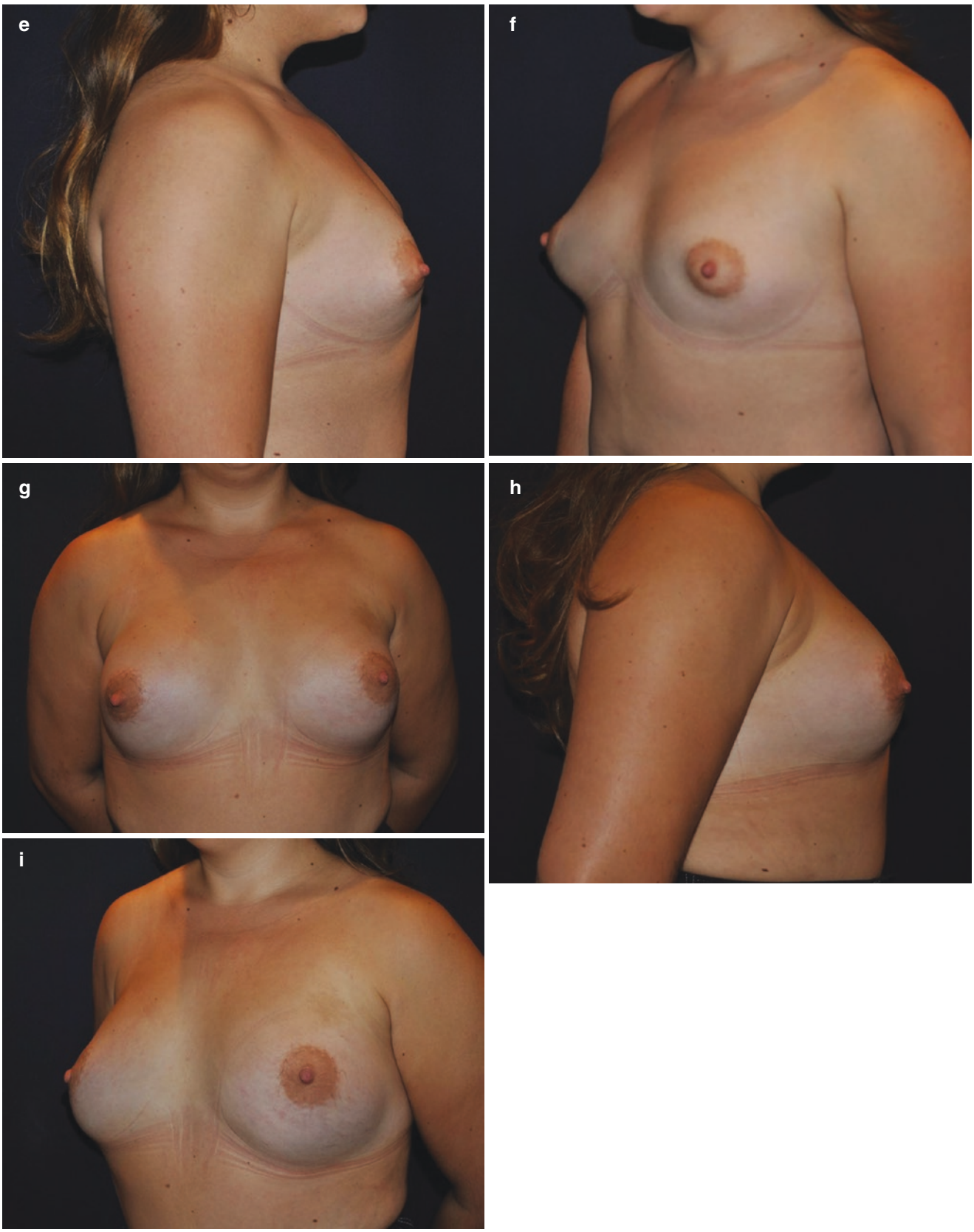


**Fig. 11.5** (continued)


**Fig. 11.6** (**a**, **b**) Preoperative vies of a 28-year old female patient requesting buttocks augmentation. (**c**, **d**) Postoperative views of a 28- year old female patient 3 years after undergoing SEL buttocks augmentation

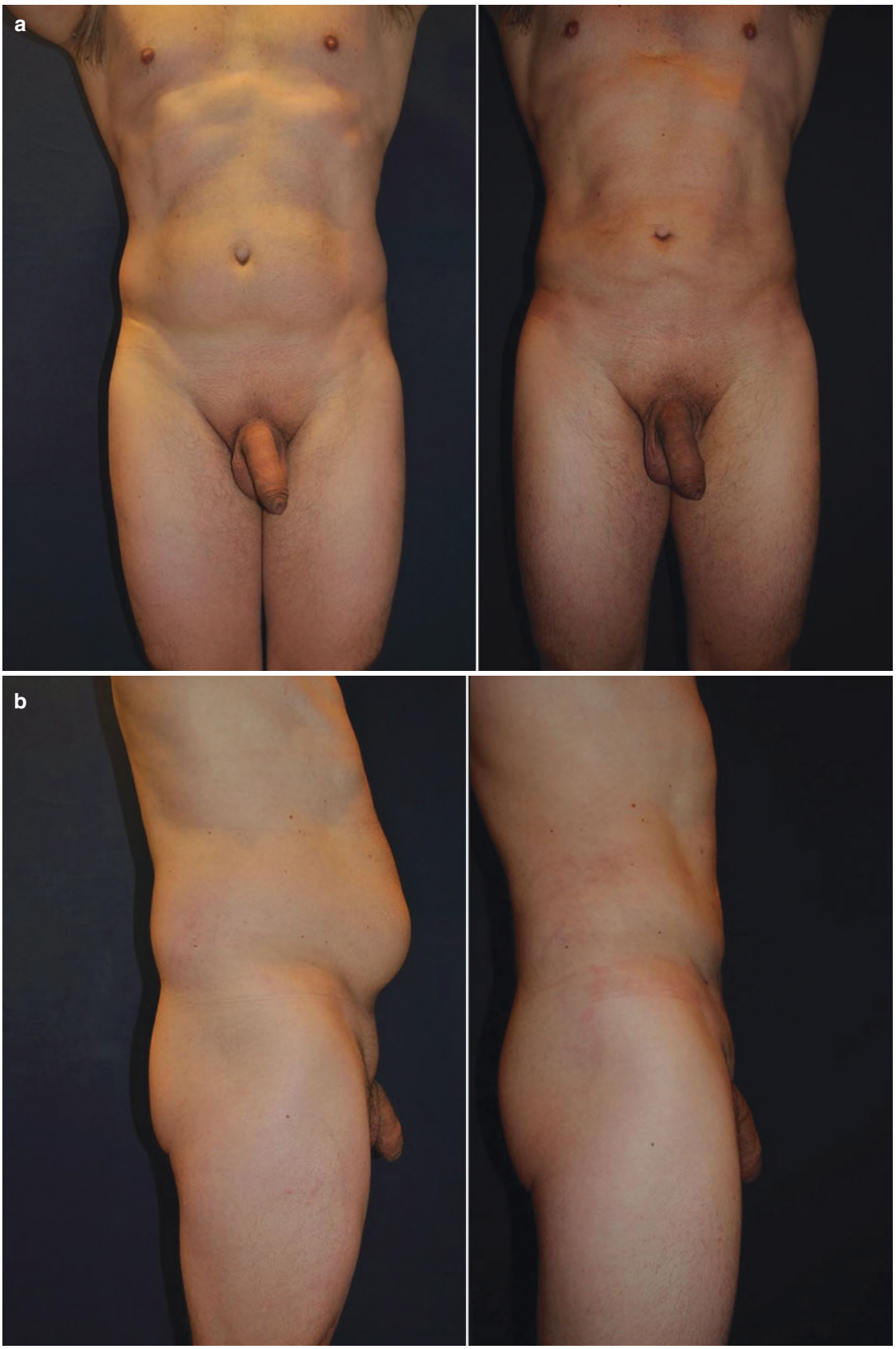


**Fig. 11.7** (**a**–**c**) Preoperative views of a 35-years old male patient complaining about his body shape. (**d**–**f**) Postoperative views of a 35-years old male patient 2 years after undergoing liposuction and gluteal augmentation by SEL

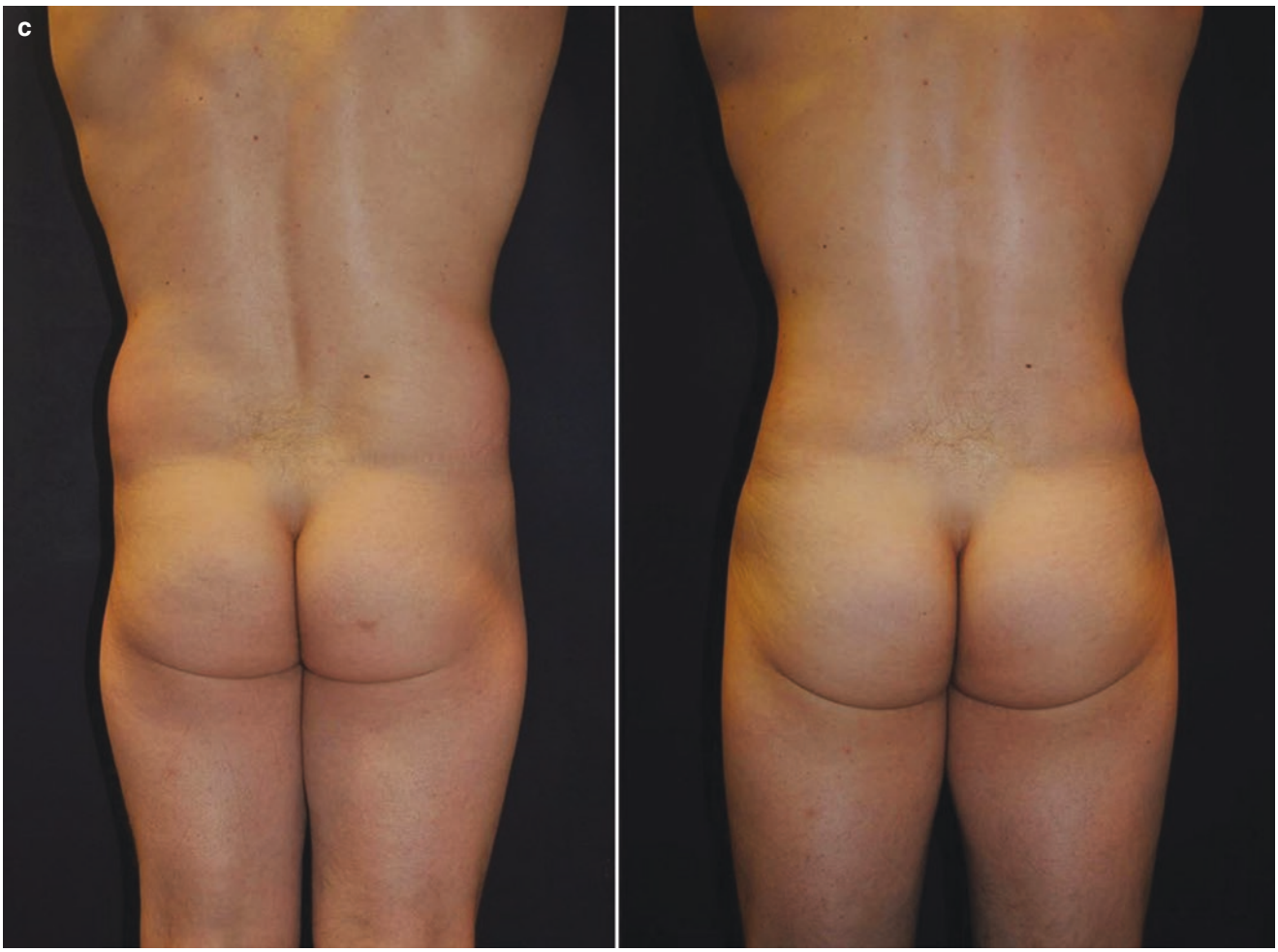


**Fig. 11.7** (continued)

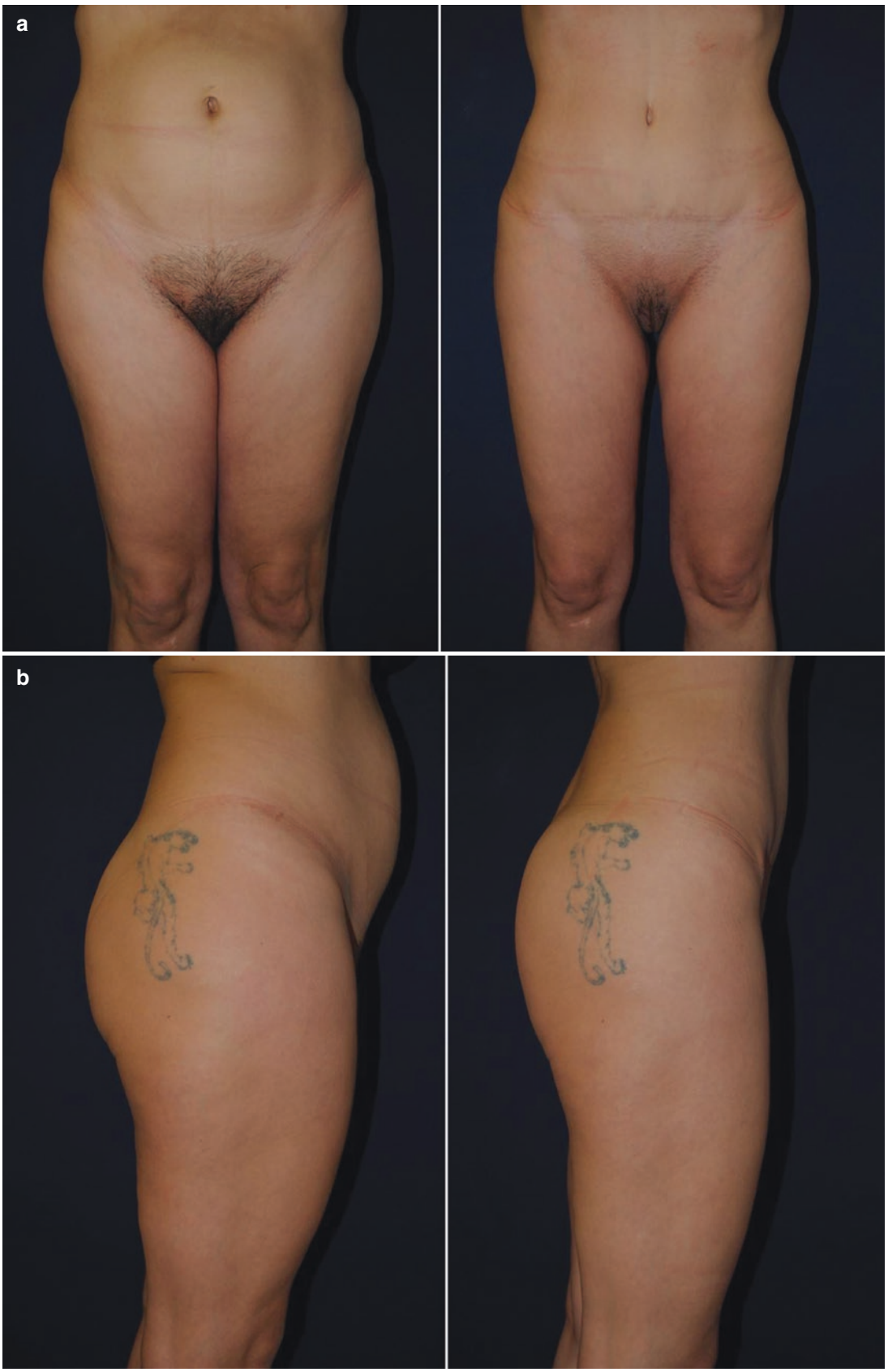


**Fig. 11.8** (**a**–**c**) Preoperative views of a 51-year old female patient complaining about her body. (**d**–**f**) Postoperative views of a 51-year old female patient 4 years after undergoing lipoabdominoplasty and gluteal augmentation by SEL

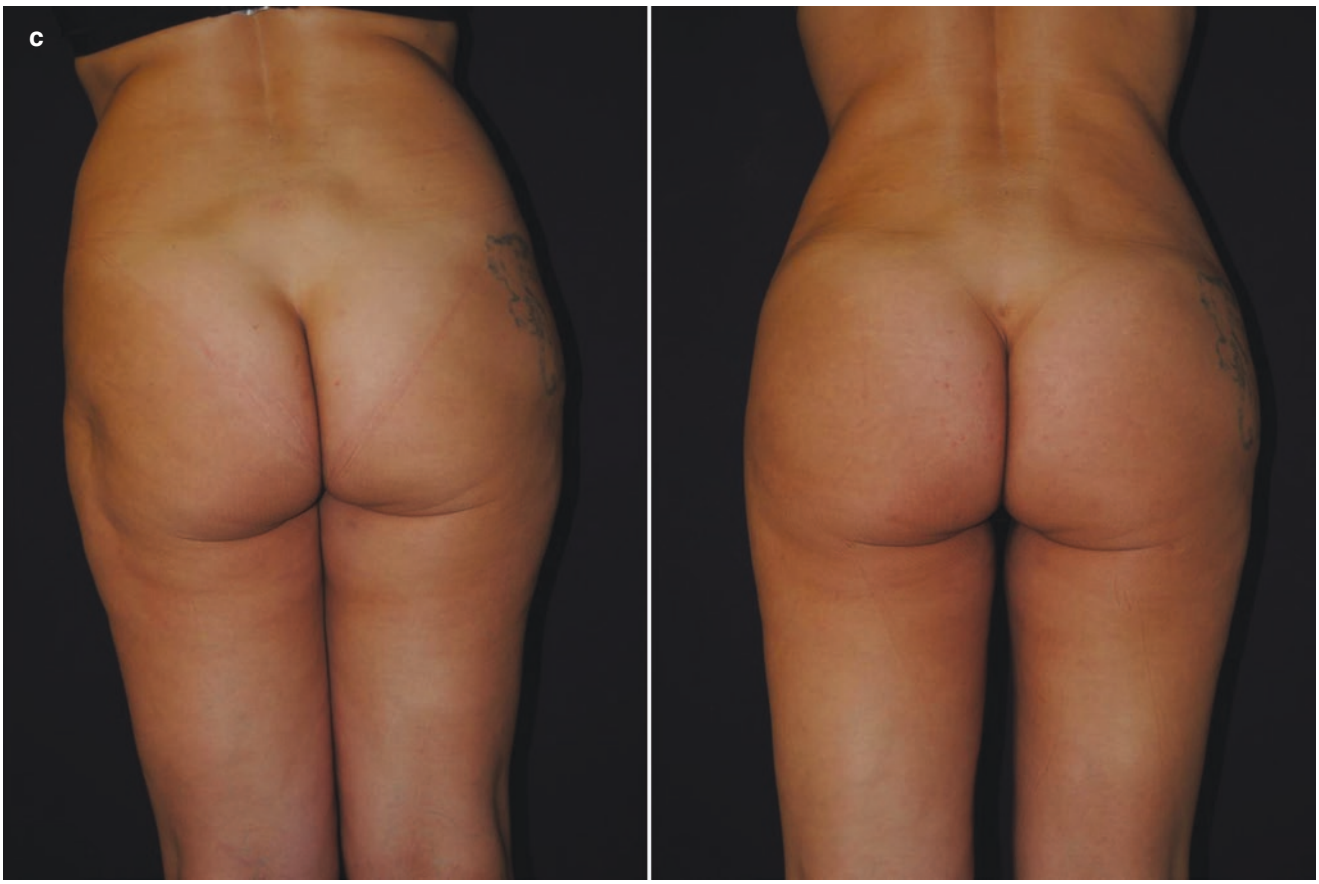


**Fig. 11.8** (continued)

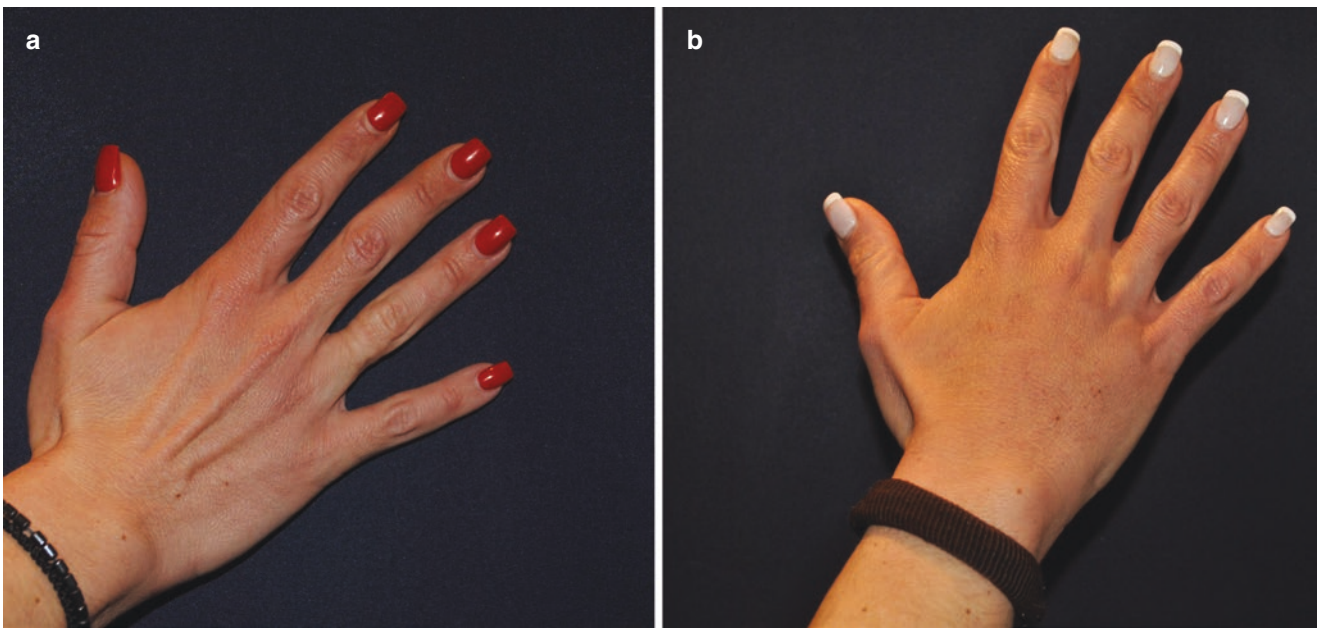


**Fig. 11.9** (**a**) Preoperative view of a 73-year-old woman presented complaining of her "unattractive" hands. (**b**) Postoperative view of a 73-year old woman 2 year after undergoing SEL transfer to the hands


**Fig. 11.10** (**a**) Preoperative view of 42-year old female patient requesting rejuvenation of her external genitalia. (**b**) Postoperative view of a 42-year old female patient 1 year after SEL of the external genitalia

## 11.5 Discussion

Fat grafting for face and body contouring remains shrouded in the stigma of variable results experienced by most plastic surgeons when they first graft fat. The need of standardization of the autologous fat-grafting technique needs to be done. Numerous clinical reports have been published regarding techniques of fat graft harvesting, preparation, and injection. Techniques are still selected according to a surgeon's individual preference, since quantitative evidence of clinical fat survivability and predictability of volume restoration does not exist. ADSCs can be distinguished from other adipocyte progenitor populations based on their expression of a variety of surface markers. The regenerative capacity of ADSCs during graft setting and their contribution to fat regeneration has been proven [9]. Stromal vascular fraction (SVF) is a heterogeneous population of cells that results from the processing of adipose tissue and is composed mainly of various blood cells, pericytes, macrophages, smooth muscle cells, and both adipose-derived and vascular endothelial progenitor cells. The factor in successful engraftment is the presence of ADSCs. These cells are pluripotent mesenchymal stem cells that reside in large numbers in adipose tissue. These small stellate-shaped cells are identified by surface antigens such as CD134 and their ability to form colonies in vitro. It is estimated that 1–3 million of these small stellate-shaped cells typically reside in proximity to small vessels of adipose tissue. They are known to tolerate the conditions associated with harvest and graft injection more successfully than mature adipocytes, participate in the tissue response to these stresses, and direct adipose tissue regeneration. ADSCs are able to differentiate into new adipocytes, replacing a portion of the adipocytes, which succumb to apoptosis due to hypoxic or physical stress and have been shown to actively promote angiogenesis via growth factor secretion and through neovascular differentiation. Clinical studies have demonstrated that the resident ADSCs within fat-grafted tissues can differentiate into adipocytes and add structure to fill the implanted tissue defect; secrete growth factors, cytokines, and chemo-attractants that can enhance angiogenesis and increase local vascularization and blood supply; and inhibit innate immune responses after tissue transplantation [11]. Recent studies have indicated that ADSCs can promote angiogenesis in addition to suppressing inflammation. An accepted principle of autologous fat grafting is that adipocytes survive only within 2 mm of an arterial blood supply. Fat cells outside this boundary may undergo necrosis leading to scar tissue. The adipose tissue graft enriched with SVF is woven into the targeted tissues, injecting only 5–10 mL of fat with each pass as in order to obtain

the most reliable clinical outcome. The process of fat regeneration is progressed by ADSCs between 3 and 7 days, so the role of ADSCs is important in fat grafting. ADSCs are also involved with establishing fat homeostasis. These properties support successful tissue regeneration and the long-term survival of the fat graft. It has been shown that ADSCs harvested from superficial abdominal regions are significantly more resistant to apoptosis than other parts [12].

A series of clinical cases have shown that fat graft enriched with adipose-derived stem cells can improve the survival rate of the traditional fat graftting. In 2005, the research team led by the author Dr. Sterodimas described a method of supplementing the lipoaspirate used for fat grafting with the stromal vascular fraction found in adipose. This process was named Stromal-Enriched Lipograft [13]. The rationale behind this technique is that aspirated adipose tissue is poor in progenitor cells, growth factors, and cytokines, which are contributing factors to poor survival in vivo of the fat graft. While certain aspiration sites were initially thought to produce better graft take, these theories have not been supported by recent studies. In the SEL technique, the donor sites are chosen together with the patient, and care is taken in order to avoid reharvesting fat from a previous lipoaspiration site and not to create contour deformities. A stromal vascular fraction (SVF) containing ADSCs is freshly isolated from half of the aspirated fat and recombined with the other half. This process converts relatively ADSC-poor aspirated fat to ADSC-rich fat. SEL is based on the use of adipose-derived stem cells combined with a biomaterial that is the adipose tissue that has been processed to be used as a natural scaffold and biomolecules, cytokines, and growth factors, which are secreted by the stem cells and the adipose tissue [14]. A recent study has confirmed that SEL fat can survive better than non-SEL fat, and microvasculature can be detected more prominently in SEL fat, especially in the outer layers of the fat transfer [15].

### 11.5.1 Face SEL

The use of SEL can augment certain areas of the breast, for example, in the midline to build cleavage, adding upper pole fullness, or under the intended nipple position to provide additional projection, which cannot be achieved by the insertion of silicone implant alone. SEL can effectively improve implant animation deformity, rippling, and visibility of the implant in décolletage. With aging, soft tissue loss is inevitable, and the skin of the dorsal surface of the hand becomes thinner, thereby revealing extensor tendons and dorsal veins. Successful, three-dimensional sculpting of the hand requires attention to patient preparation, meticulous planning, and optimizing the harvesting and transplantation of adipose tissue. Hand rejuvenation by SEL™ aims at successfully reversing this three-dimensional process. Recent reports showed ADSCs as a powerful source of skin regeneration because of their capability to provide not only cellular elements, but also numerous cytokines. A standardized technique of combining liposuction of lumbosacral, subgluteal, and trochanteric areas with lipoinjection in the upper middle buttock to improve the gluteal contour together with the projection of the gluteus is paramount for a successful gluteal fat grafting. Deep knowledge of the topography of the gluteal region and familiarity with the technique are essential in order to safely reach a pleasant result.

## 11.6 Conclusion

SEL is a safe and acceptable method for face, breast, and body fat-grafting surgeries due to its high patient satisfaction and low complication rate. Future research will hopefully refine our understanding of the effect of fat grafting on the local tissue micro-environment and provide clues toward its optimization. In addition, large-scale, controlled studies are needed to advance our ability to tailor the SEL technique for further applications in the field of plastic & reconstructive surgery.

## References

1. Sterodimas A, Boriani F, Magarakis E, Nicaretta B, Pereira LH, Illouz YG. Thirty-four years of liposuction: past, present and future. Eur Rev Med Pharmacol Sci. 2012;16(3):393–406.
2. Sterodimas A, De Faria J, Correa WE, Pitanguy I. Tissue engineering in plastic surgery: an up-to-date review of the current literature. Ann Plast Surg. 2009;62(1):97–103.
3. Sterodimas A, de Faria J, Nicaretta B, Pitanguy I. Tissue engineering with adipose-derived stem cells (ADSCs): current and future applications. J Plast Reconstr Aesthet Surg. 2010;63(11):1886–92.
4. Sterodimas A, de Faria J, Nicaretta B, Papadopoulos O, Papalambros E, Illouz YG. Cell-assisted lipotransfer. Aesthet Surg J. 2010;30(1):78–81.
5. Sterodimas A, Illouz YG. Conclusions and future directions. In: Illouz YG, Sterodimas A, editors. Adipose derived stem cells and regenerative medicine. Berlin Heidelberg: Springer-Verlag; 2011. p. 273–6.
6. Pereira LH, Sterodimas A. Composite body contouring. Aesthetic Plast Surg. 2009;33(4):616–24.
7. Sterodimas A. Stromal enriched lipograft for rhinoplasty refinement. Aesthet Surg J. 2013;33(4):612–4.
8. Sterodimas A, Huanquipaco JC, de Souza FS, Bornia FA, Pitanguy I. Autologous fat transplantation for the treatment of Parry-Romberg syndrome. J Plast Reconstr Aesthet Surg. 2009;62(11):e424–6.
9. Sterodimas A, de Faria J, Nicaretta B, Boriani F. Autologous fat transplantation versus adipose-derived stem cell-enriched lipografts: a study. Aesthet Surg J. 2011;31(6):682–93.
10. Nicareta B, Pereira LH, Sterodimas A, Illouz YG. Autologous gluteal lipograft. Aesthetic Plast Surg. 2011;35(2):216–24.
11. Sterodimas A, Pereira LH. Liposuction of the abdomen and trunk. In: Rubin JP, Jewell ML, Richter D, Uebel CO, editors. Body con-

touring & liposuction. New York, NY: W.B. Saunders Elsevier; 2012. p. 311–20.
12. Sterodimas A. Adipose Stem cell engineering: clinical applications in plastic and reconstructive surgery. In: Illouz YG, Sterodimas A, editors. Adipose derived stem cells and regenerative medicine. Berlin Heidelberg: Springer-Verlag; 2011. p. 165–80.
13. Sterodimas A. Tissue engineering with adipose derived stem cells (ADSCs) in plastic & reconstructive surgery: current and future applications. In: Di Giuseppe A, Shiffman MA, editors. New frontiers in plastic and cosmetic surgery. Jaypee; 2015.
14. Sterodimas A, Nicaretta B. Filippo Boriani composite face lifting: the combination of stromal enriched lipograft with face minilift and upper and lower blepharoplasty: a review of 210 cases. Ann Plast Surg. 2020;85(6):e20–3.
15. Gentile P, Sterodimas A, Calabrese C, De Angelis B, Trivisonno A, Pizzicannella J, Dionisi L, De Fazio D, Garcovich S. Regenerative application of stromal vascular fraction cells enhanced fat graft maintenance: clinical assessment in face rejuvenation. Expert Opin Biol Ther. 2020;20(12):1503–13.