



Breast Reconstruction with External Expansion and Fat Grafting

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Introduction

The use of autologous fat grafting (AFG) is widely used in plastic surgery for both reconstructive and aesthetic indications, in particular for breast and buttock augmentation and facial rejuvenation [1–5]. AFG is a simple and effective procedure presenting several advantages. Among them is the possibility of combining liposuction of areas with unpleasant accumulation with volumetric enhancement and reshaping of anatomical regions where augmentation is sought. Moreover, regeneration capacity is recognized to the graft, as a copious literature has investigated the role of adipose-derived stem cells contained in its stromal vascular fraction. Importantly, this potential has encouraged its clinical application for the therapy of scars, scar-related conditions, and burns [6, 7].

However, volume retention rates of AFG vary largely in a range between 30% and 80% [3]. Several factors contribute to the success of the procedure, and a vast research has been performed to optimize three steps of the procedure: modalities of harvesting, processing, and reinjection [1–5]. Instead, less attention has generally been attributed to the preparation of the recipient site prior to AFG. Nevertheless, there is evidence that this last point appears to be extremely relevant to ensure improvement of outcomes and reduction of complication [1, 2].

The characteristic of the recipient site which impact AFG can be summarized as follows: age of the patient, trauma, burns, scars, structural defects, face compartments, and mobility [5]. Our group has recently comprehensively analyzed all preclinical and clinical evidence supporting the use of techniques to prepare the recipient site, with a focus in breast surgery [1, 2]. Several procedures were

studied preclinically, including external volume expansion (EVE), microneedling, implantation of alloplastic materials, administration of cell-proliferating factors, and ischemia. Although all procedure unequally showed positive outcomes in terms of fat graft survival, vascularity, cell proliferation, skin thickness, quality of tissue, and inflammation, only EVE has been extensively applied clinically. Moreover, the preclinical research conducted on EVE offers the most robust evidence. At the clinical level, 14 studies have investigated the use of EVE in breast surgery. The majority of these studies used the Brava system (Brava LLC, Miami, Fla.), a bra-like device which applies low negative pressure to the breast during the weeks before AFG [4, 8–19]. Another option was published by our group, with the use of a device named VAC-6000 M with a Palm Pump (Clinical Innovations, South Murray, Utah), to treat localized breast contouring defects and contracted scars with a strong negative pressure [20].

Pre-expansion was investigated preclinically observing increased cell proliferation, angiogenesis, adipogenesis, hair follicles number, and skin thickness with enhanced fat graft survival [21–26]. The mechanism of action was explained with an inflammatory reaction caused by cell strain, ischemia, and edema generated by the controlled noninvasive suction. In the clinical context, the first use of Brava as EVE of the breast was presented by Khouri et al. in 2000 to perform nonsurgical breast augmentation, based on the principle of tissue growth caused by controlled distractive mechanical forces [27]. It was afterward combined with AFG as a preparation technique due to its capacity of generating an ideal environment for fat graft survival. Kiwi VAC-6000M with a Palm Pump is the sole alternative to the use of Brava as pre-expansion device, used for the different indication of preparing localized recipient sites with the application of strong negative pressure for short times. With the use of Kiwi were observed satisfactory clinical outcomes with high patient acceptance and compliance and minimal morbidity.

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Patient Selection

Several surgical indications for EVE prior to AFG to the breast were described [2, 4, 8–20]. In particular the use of Brava is indicated in case of breast reconstruction after treatment for cancer, breast augmentation for aesthetic purposes, correction of congenital or iatrogenic deformities, and replacement of previous implants. In general, it is indicated for those patients whom the totality of the breast required to be treated. In these patients also mega-volume AFG (>300 ml) becomes possible [15]. Instead, the use of Kiwi VAC-6000M with a Palm Pump is indicated for patients presenting with localized contracted scars or breast contouring deformities, also as a result of radiation therapy, requiring only small volume enhancement (up to 80 ml) [20].

The use of Brava has been supported by Del Vecchio and Bucky for all those cases requiring the creation of a larger parenchymal space, the reduction of interstitial pressure in the breast for a given volume of transplanted graft, correction of contour irregularities through breast reshaping prior to AFG, and increased vascularization as a result of micro-mechanical forces applied on the recipient site [15].

Particular attention must be posed for patients with less compliant recipient sites due to mechanical reasons: constricted breasts, dense nulliparous breasts, and pre-irradiated breasts [15]. In these situations, additional sessions of AFG or procedures such as release of constriction bands may be needed. Moreover, the use of EVE in pre-irradiated tissues remains an area of debate. In particular, Uda et al. [17] discouraged the use of Brava in this case, due to the higher rate of complications, in particular ulceration, while Kosowski et al. [19] supported its use postulating that the regeneration potential of AFG would be able of reversing radiation damage and improve outcomes. However, they also recommended to avoid over-grafting due to the less compliance of the recipient site and to prefer a series of multiple AFG sessions.

Finally, an accurate selection of the patients must also include the evaluation of their compliance, in particular with reference to the Brava system, as the device required to be worn for weeks may generate an impact on patient social life [2]. Instead, the use of Kiwi was reported to be easily tolerated and only requires certain ability of the patient to follow the postoperative recommendations [20].

Patient Preparation

The patients are requested to prepare their breast with Brava for 10–24 h/day for a period starting up to 4 weeks before the operation [2, 4, 8–19]. The preparation of the recipient site with the Brava system has been performed with a wide range of different pressure values. In the initial description of the

device by Khouri et al., a negative pressure of -15 to -25 mm Hg is applied to the breast [27]. The following studies reported pressures cycling between -60 and 0 mmHg preoperatively and pressures cycling between -80 and -60 mmHg [12, 19].

Del Vecchio and Bucky highlighted the importance of a careful analysis of the psychological compliance of the patient and her lifestyle in order to adapt the use of the device to each patient individual needs [15]. This individualized approach is conducted to the application of a negative pressure ranging between -1 and -3 in. of mercury (-25.4 to -76.2 mmHg) [13].

Surgical Technique

The use of Kiwi VAC-6000M with a Palm Pump is the sole technique with intraoperative application (Fig. 10.1) [20]. The device, which was originally described and commonly used as complete vacuum delivery system, is applied on localized contracted scars and breast contouring defects and scarred recipient sites generating intense cycling negative pressures equal to -550 mmHg, for a series of 10 times of 30 s each, before AFG. Kiwi determines a gross expansion of tissue, with macroscopic swelling inflammation and ischemia to generate an ideal environment for cell proliferation and angiogenesis and thus improved AFG outcomes (Fig. 10.2).

The infiltration of the donor site is performed with a modified Klein solution (lidocaine hydrochloride, 0.91 mg/ml; epinephrine, 1.8 μ g/ml) as previously described by our group [28]. The fat is harvested 15 min after completion of infiltration through hand-assisted liposuction using a blunt three opening cannula (cannula diameter, 4 mm; cross sectional area, 12.6 mm²; oval opening, 2 \times 4 mm; area, 6.3 mm²; Lenoir System AG, Roggwil, Switzerland) [28]. The lipoaspirates are then processed through centrifugation at 920 g for 3 min and transferred to 10-cc syringes (opening diameter, 2 mm; area, 3.1 mm²; Becton Dickinson AG, Basel, Switzerland) con-



Fig. 10.1 The Kiwi VAC-6000M with a Palm Pump (Clinical Innovations). (Reproduced with permission from Oranges et al. [20])

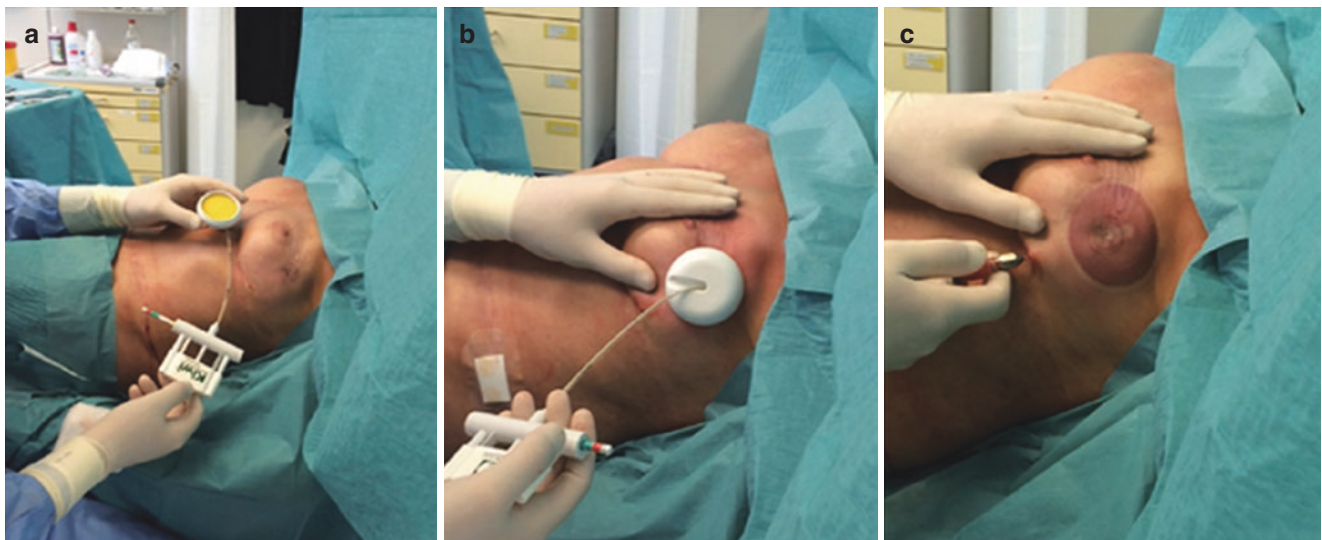


Fig. 10.2 (a, b) The Kiwi is applied on a scarred pre-irradiated breast. (c) During the repetitive stimulation, macroscopic swelling of the soft tissue is observed. (Reproduced with permission from Oranges et al. [20])

nected to a second empty 10-cc syringe at a 90-degree angle through a three-way stopcock (diameter, 2 mm; area, 3.1 mm²; Becton Dickinson) [28]. The lipoaspirates are shuffled by transferring the content of one syringe into the other 10 times [28]. The injection of the fat graft is finally performed with a 10 ml Luer Lock syringe connected to one of the cannulas of the Coleman™ Microinjection System, chosen according to the characteristics of the recipient site.

Technical Variation

Khouri et al. described a megavolume fat grafting procedure [12, 29, 30]. The harvesting is performed over a large area with a 12-hole, 2.7-mm cannula connected to a 300-mmHg syringe (KVAK Syringe; Lipcosm, LLC, Key Biscayne, Fla.) through multiple needle puncture entry sites. The lipoaspirates are processed with centrifugation at 15 g for 2 min and then diffusely reinjected through multiple needle entry sites with 2.4-mm single-hole cannulas.

Postoperative Care

To hold open the graft construct and optimize the ideal graft-to-recipient volume ratio, the postoperative use Brava is recommended [29, 30]. In the published literature, the patients are asked to wear the device for a period ranging between 5 days and 4 weeks, for 10–24 h/day, only at night or for as many hours per day as tolerated [2]. The level of negative pressure was reported to be equal to –20 mm Hg or simply “low pressure.” Also, the postoperative use of Kiwi VAC was recommended for 3 days with 3 applications per day of 1 min each.

It is very important to inform the patients regarding possible dermatologic complications, as observed by Hammer-Hansen [18]. On this regard, our comprehensive review found the following skin complications: temporal bruising and superficial blistering, 11.3%; erythema, 1.4%; ulceration necrosis, 1.4%; pruritus, 1.1%; phlyctens, 0.1% [2]. We also observed that the most common complications were localized edema (14.2%), temporary bruising and superficial skin blisters (11.3%), and fat necrosis (8.2%) [2].

Clinical Case

A 67-year-old woman presented with a complaint of contracted scar tissue on the right breast following breast-conserving surgery and radiation therapy (Fig. 10.3) [20]. The recipient site was prepared intraoperatively for AFG with application of Kiwi, which was also used 3 times/day for 3 days after the operation. A total amount of 40 ml fat was transplanted. Early postoperative pictures show scar release and volume restoration.

Conclusions

There is emerging evidence that the preparation of the recipient site through EVE can enhance outcomes of AFG. Its use can be recommended for both aesthetic and reconstructive indications in breast surgery. Preoperative selection of the appropriate candidate and treatment protocol is a key aspect for the success of the procedure. It is essential to verify the psychological compliance of the patient to the use of Brava and to identify the mechanical compliance of the recipient

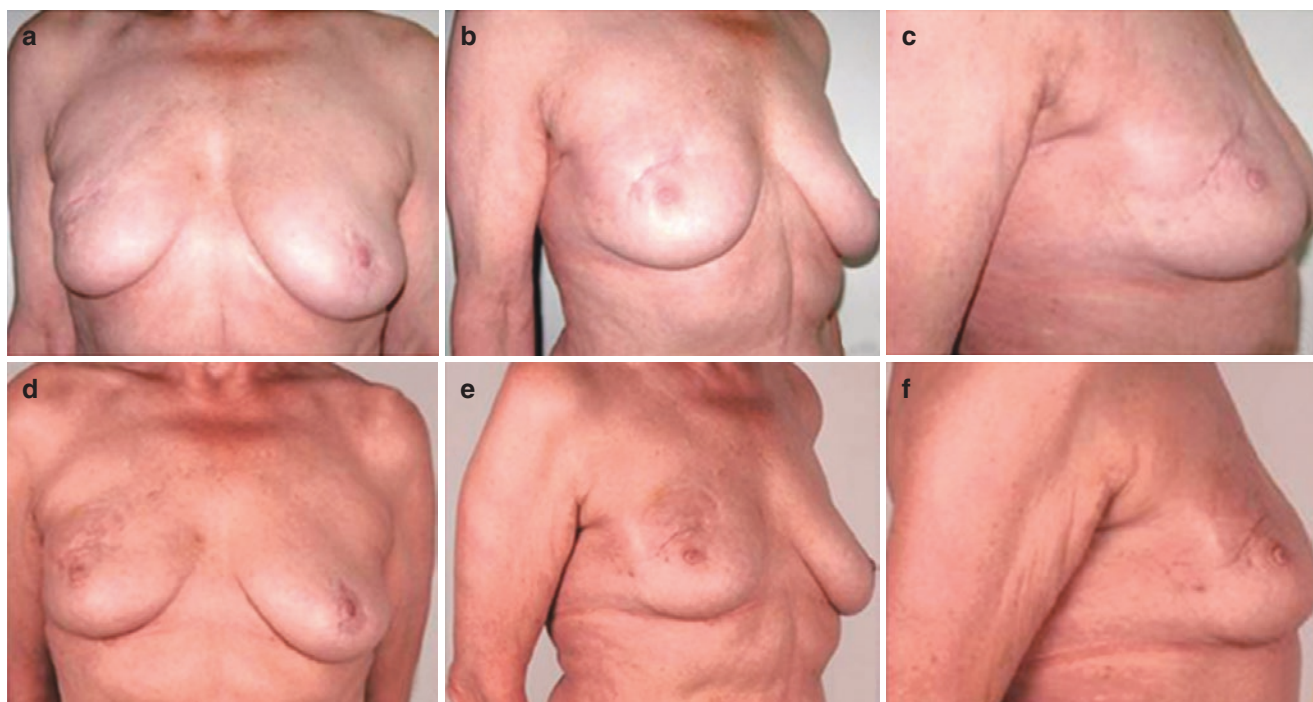


Fig. 10.3 Preoperative (a–c) and early postoperative (d–f) images of a patient receiving AFG after preparation of the right breast with Kiwi. (Reproduced with permission from Oranges et al. [20])

site to the expansion process, adequately plan an optimal number of AFG sessions, and eventually perform additional surgeries such as contraction release. A significant advantage of its use is the ability of preparing the breast to receive megavolume AFG (>300 ml). Although also supported by preclinical evidence, the relative low level of evidence of the studies conducted so far involves the need of further research. Finally, the use of Kiwi is a good option for cases characterized by contracted scars and breast contouring defects where small volume fat grafting is required (up to 80 ml).

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