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Refined Method of Lipofilling following DIEP Breast Reconstruction: 3D Analysis of Graft Survival

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Background: The deep inferior epigastric perforator (DIEP) flap technique gives good clinical results, but aesthetic surgical adjustments are often necessary. Lipofilling represents a good complementary method, but fat resorption within the few months after surgery limits its use. Recently, a new protocol was introduced and successfully evaluated on murine models. This study aims to evaluate this protocol following a DIEP procedure by three-dimensional analysis.

Methods: Within a period of 4 months, every patient having undergone breast reconstruction with DIEP and who required a lipofilling adjustment was invited to take part in this study. All surgeries were performed using the Adip'sculpt disposable medical device MACROFILL (Laboratoires SEBBIN, Boissy-l'Aillerie, France). Fat resorption was analyzed using a three-dimensional photography system.

Results: Twenty-three patients were included, with a total of 25 breasts operated on. Injections were carried out on irradiated breasts in 73% of cases, and average injection volume was 124 mL (SD = 39 mL), whereas average operating time was 68 minutes (44–96 minutes). At an average follow-up of 5 months (4–8 months), 70.9% of projection gain afforded by the lipofilling was still present.

Conclusions: It is now clear that particular rules should be respected for an efficient lipofilling, particularly regarding aspiration cannula characteristics, vacuum used, and the necessity of washes and soft centrifugations. We demonstrate here that by following a specific protocol that addresses these precautions, while using material that is specifically adapted, a 70.9% fat survival rate can be achieved, even in the very unfavorable case of postirradiation DIEP breast reconstruction. *(Plast Reconstr Surg Glob Open 2015;3:e526; doi: 10.1097/GOX.0000000000000495; Published online 25 September 2015.)*

The deep inferior epigastric perforator (DIEP) flap technique has emerged over the last 20 years as the solution of choice for breast reconstruction.[1–4] However, despite the good clinical results that are obtained with this technique, surgical adjustments to achieve better symmetry are often necessary.[5] Surgeons have diverse techniques at their disposal, of which autologous fat transfer stands out, with good cosmetic results attainable at the cost of a fairly nontraumatic surgical procedure.[6]

Autologous transfer of adipose tissue was first described in 1893 by Neuber,[7] but it is Coleman[8] who popularized it a century later with his "lipostructure" technique. The main feature of this technique is centrifugation of the fat, which eliminates a portion

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of the blood elements and compacts the tissue before reinjection. Despite being widely used, breast lipofilling still remains a controversial subject, mainly due to the high rate of grafted fat resorption in the months following surgery.[9] To circumvent these problems, several authors have modified the Coleman protocol to optimize graft success. Recent reports in the literature have highlighted that a reduced applied pressure during aspiration is a critical element in avoiding damage to harvested adipocytes.[10] Small suction cannulas have also been shown to promote tissue survival and vascularization.[11] Furthermore, graft survival can be improved through the removal of deleterious elements (blood, local anesthetics, inflammatory molecules, etc.) by washing the fat with a physiological solution.[12,13] Finally, centrifugation speed is also an important criterion because strong centrifugation can significantly affect the viability of adipocytes before their reinjection.[14,15]

Against this backdrop, Hoareau et al[16] recently proposed a fat treatment protocol that associates moderate harvesting pressure, successive washes, and gentle centrifugations. The authors demonstrated in a murine model that there is an improvement in the viability of fat treated with this protocol. However, to our knowledge, this technique has not been the subject of any human studies.

The evaluation of this technique in humans raises a technical question as to how can fat resorption be measured and more particularly, in this study, how can breast volume be determined. Diverse photographic, radiographic, optic, nuclear magnetic resonance imaging, and ultrasound techniques have been proposed to evaluate breast volume, each with their own advantages and disadvantages. Of these tools, the three-dimensional (3D) photographic VECTRA (Canfield Scientific, Fairfield, N.J.) technique has been shown to be precise[17,18] and has been used in several recent studies.[19,20] The use of this system is also simple and not excessively restrictive for the patient. It is for these reasons that we have chosen this technique for the study.

The aim of this study was to conduct 3D analysis to determine the fate of transferred fat in the breast following a post-DIEP refinement procedure, using a protocol that combines moderate harvesting pressure, successive washes, and gentle centrifugations.

MATERIALS AND METHODS

In our institution, between November 2013 and February 2014, every patient having undergone breast reconstruction with DIEP and who required a lipofilling adjustment was invited to take part in this study. We have carried out the lipofilling with the single-use Adip'sculpt MACROFILL kit (Laboratoires SEBBIN, Boissy l'Aillerie, France). This kit enables the harvesting, treatment, and reinjection of fat according to the specifications of the protocol proposed by Hoareau et al.[16]

This study was performed in accordance with Helsinki Declaration, and all the subjects enrolled in this study gave oral informed consent.

Surgery

Surgery was carried out under general anesthesia. The choice of fat harvesting sites was dependent upon each patient and included the medial and lateral thighs and the sides of the abdomen. The tumescent solution was composed of 1 L of NaCl (0.9%) and a vial of 1 mL of levorenine (1 mg/mL). Infiltration was conducted with a ratio of 1 mL of tumescent solution for 1 mL of harvested fat.

Harvesting was carried out incrementally with 60 mL syringes to harvest with a maximum pressure of 0.45 bars. Ten-hole (holes of 2.5 mm diameter) 3.5 mm diameter cannulas were used for harvesting. After removal of around 45 mL of tissue, the remaining volume of the syringe was completed with NaCl solution (0.9%) to wash the fat. The syringe was gently agitated and then centrifuged at 1000 rpm (100*g*) for 1 second to reduce decantation time. After evacuation of the subnatant fluid, the washing step was repeated, followed by centrifugation at 2000 rpm (400*g*) for 1 minute.

Thus, the purified fat was transferred into 10 mL syringes and then injected with 2.1-mm-diameter cannulas.

In certain patients, liposuction was carried out in the upper pole of the breast to reduce the frequently observed volume excess of this zone following DIEP reconstruction.

Operating Time

The operating time was noted in the anesthetists' reports. It was measured between the intubation and extubation times.

3D Photography

Each patient was given the opportunity to undergo preoperative 3D photography with the VECTRA system (Canfield Scientific, Fairfield, N.J.), then after 15 days, 1 month, and then every month up to a maximum of 8 months postoperative. Acquisition was carried out in a standardized position, patient standing with their hands on their hips. Each acquisition was compared with the initial preoperative acquisition. Increase in volume was characterized by local increases in measured projection with the VAM Analysis software (Canfield Scientific, Fairfield, N.J.) (Fig. 1).

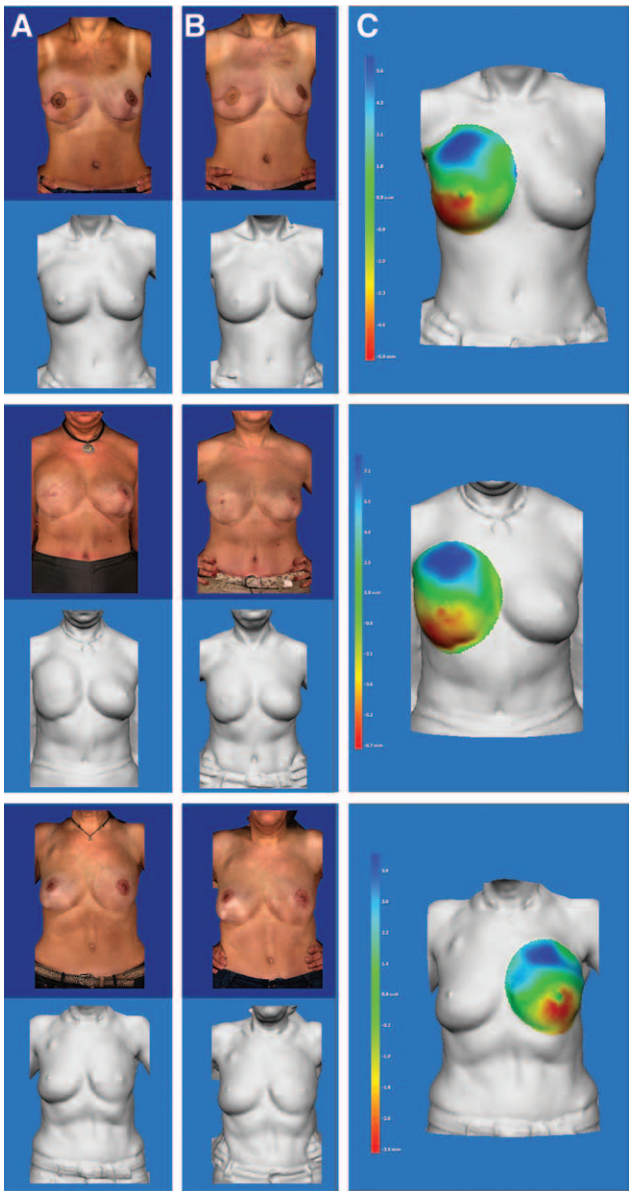

Fig. 1. Representative results of 3D photography analysis on 3 patients. A, Preoperative photographs. B, postoperative (4 months) 3D acquisitions. C, 3D mapping of projection differences between preoperative and postoperative acquisitions. Red areas represent augmentation of projection (positive), whereas blue areas represent decrease of projection (negative). The association between the color and the variation of projection in millimeters is indicated in the figure.

Patients who did not benefit from a minimum follow-up of 4 months were excluded from the study.

RESULTS

Forty-two patients seen in our institute between November 2013 and February 2014 met the criteria for inclusion. Of these, 23 patients benefited from 3D imaging follow-up for at least 4 months. These 23 patients, with an average age of 51.5 years (SD = 7.4 years; range, 37–66 years) and an average body mass index of 22.7 kg/m² (SD = 2.7 kg/m²; range, 17.9–29.0 kg/m²), were thus included in the study with a total of 25 breasts operated. On average, 17 months passed (4–98 months) between the DIEP reconstruction and the fat transfer. The average injection volume was 125 mL (SD = 38 mL; range, 55–240 mL). The injection was carried out on irradiated breasts in 72% of cases (Table 1). The donor sites included the interior of the thighs in 80% of cases, the outside of the thighs in 67% of cases, and the sides of the abdomen in 60% of cases.

The average operating time was 68 minutes (44–96 minutes). In 48% of cases, lipofilling was associated with one or several additional procedures (correction of abdominal scar in 26% of cases, correction of the submammary fold in 17% of cases, nipple reconstruction in 13% of cases, correction of visible scar in 4% of cases, and removal of an implantable catheter port in 4% of cases).

At 15 days postoperative, projection at the injection site increased by an average of 9.0 mm compared with the preoperative situation. When the final 3D examination of each patient after an average follow-up of 5 months (4–8 months) was considered, a 70.9% increase in projection was still present (6.3 mm of projection at the final examination). Although most patients have previously undergone radiotherapy, no significant differences could be noticed between nonirradiated and irradiated breasts.

Figure 2 shows the monthly evolution of projections in the liposuction and injection zones, with extrapolations where the patients missed their appointments (24% of appointments). The majority of resorption occurred in the first 2 months postoperative, with a 77.7% increase in projection that remained stable after this length of time. We noted that there was stabilization of the resorption from the third month postoperative with, at 4 months, conservation of 72.4% of the projection increase. Beyond 4 months (for 6 patients), the average of resorption between 4 months and the last follow-up was 3% (0–8% according to patients) (Table 1).

Liposuction of the upper pole conducted in 48% of patients brought about a 5.6 mm reduction in projection with no statistically significant variation over time.

DISCUSSION

Patients presenting for breast symmetry adjustment following DIEP reconstruction are classically women who underwent multiple operations and for whom the prospect of undergoing a fairly nontraumatic procedure, such as lipofilling, to finish their treatment seems very appealing. Moreover, it has been

Table 1. Patients and Procedure Information

Patient No.	Laterality	Age at Surgery (y)	Body Mass Index (kg/m²)	Radiotherapy	Duration between DIEP and Lipofilling (months)	Surgery Duration (min)	Additional Procedures	Injected Volume (mL)	Follow-up (months)	Graft Survival Rate at 4 Months (%)	Graft Survival Rate at Last Follow-up (%)
1	Left	51	22.2	Yes	23.0	58	No	135	4	79	79
2	Left	66	23.7	Yes	20.3	57	Yes	140	4	86	86
3	Left	56	21.6	Yes	19.3	53	No	110	4	23	23
4	Right	48	20.6	No	7.1	68	Yes	120	4	77	77
5	Left	53	23.0	Yes	4.6	55	Yes	120	4	100	100
6	Left	60	27.7	No	98.1	65	No	120	4	69	69
7	Left	59	23.7	Yes	49.5	70	No	140	8	86	78
8	Left	59	20.8	Yes	5.7	67	No	135	4	80	80
9	Right	51	21.8	No	3.9	70	Yes	80	4	83	83
10	Left	60	20.8	No	5.0	63	No	240	8	68	68
11	Right	45	20.3	Yes	8.7	71	Yes	140	4	60	60
12	Left	62	20.7	Yes	24.2	44	No	110	4	67	67
13	Left	52	21.6	Yes	8.3	84	Yes	110	4	44	44
14	Left	45	23.3	Yes	12.7	94	Yes	120	4	89	89
15	Right	37	27.3	Yes	11.0	58	Yes	80	4	85	85
16	Right	56	21.2	No	21.6	68	No	80	5	93	91
17	Bilateral	49	21.6	Yes	5.1	87	No	120/120	4	69/59	69/59
18	Right	43	25.5	No	5.3	82	Yes	160	8	99	97
19	Bilateral	46	23.7	Yes	11.1	96	No	170/150	4	50/62	50/62
20	Right	52	19.9	Yes	8.1	73	Yes	170	4	86	86
21	Right	42	25.1	No	7.6	75	Yes	55	4	58	58
22	Right	51	29.0	Yes	21.4	61	No	80	8	81	81
23	Left	41	17.9	Yes	9.7	56	No	120	7	58	52

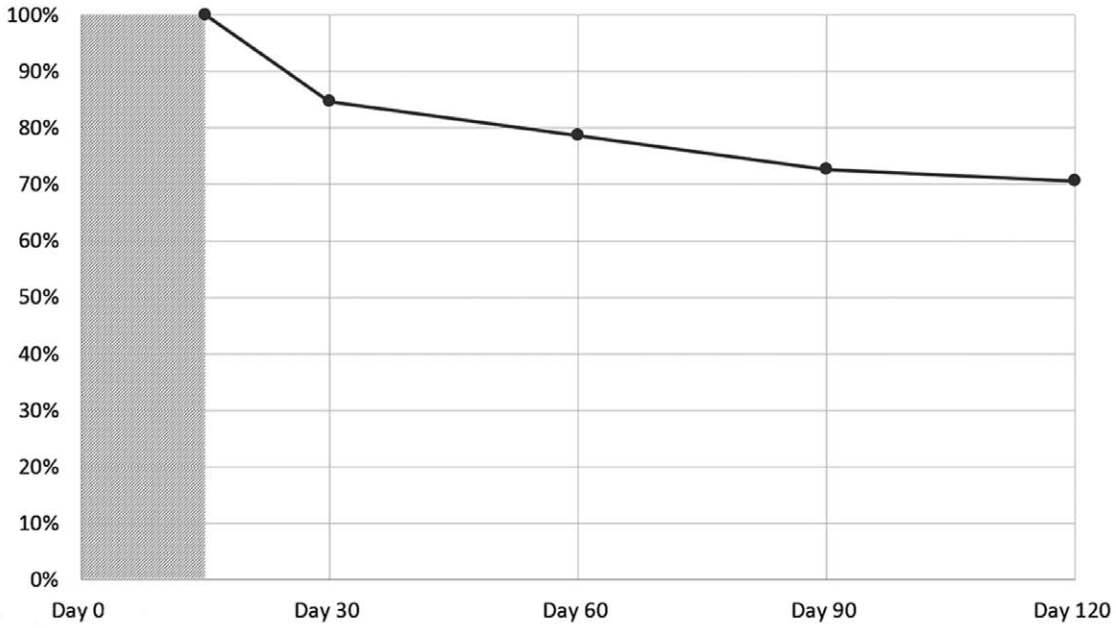

Fig. 2. Fat graft survival represented as the evolution of breast projection at the injection area over 4 months after surgery. Maximum projection augmentation (100%) is defined as the projection at the first postoperative assessment (15 days).

shown that this technique could, beyond its volume increasing aspects, also enable fat flap stabilization,[21] which represents an advantage due to the fact that DIEP also possesses its own postoperative complications, the most serious of which is flap loss. Indeed, fat grafts serve as a cushion and a specialized gliding surface, avoiding kinking or twisting of the pedicle or avoiding vascular compression.[21] Furthermore, fat grafts provide an angiogenic environment that may contribute to the survival of a new anastomosis.[21] However, although now largely democratized, breast lipofilling is nonetheless underused due to the problem of fat resorption in the initial months following surgery. This fat loss can be up to 90% in certain experimental studies[22,23] and is situated between 40% and 60% in a large majority of clinical studies.[19,20,24]

The aim of our study was to evaluate a lipofilling protocol in human patients associated with a single-use surgical kit. This protocol, which had previously been successfully assessed in a murine model,[16] is based on low-pressure harvesting using moderate-sized cannulas with small-diameter holes. The protocol is completed with multiple washes of the harvested tissue, associated with mild centrifugation, before reinjection of the fat with fine-bore cannulas.

We chose to use 3D photography to evaluate fat survival over time. However, contrary to other authors who used breast volume as a unit of measurement,[19] we preferred measuring local projections in millimeters. Indeed, liposuction of the upper pole that we have carried out in combination with injection of the lower pole would have made calculation of global breast volume impractical. The initial postoperative image acquisition that served as a reference was conducted 15 days after surgery. A 15-day delay enabled us to overcome the problem of postoperative edema, which could have distorted the measurements. Although this method did not enable us to evaluate a potential loss of fat during this initial 15-day postoperative period, it did nonetheless give us a very precise idea of global fat loss. We took the decision to exclude patients who had not been monitored for a minimum of 4 months, the period after which the fat resorption phase comes to an end.[24,25]

Unsurprisingly, liposuction of the upper pole led to a reduction in projection that remained stable over time. Projection of the inferior pole, which benefited from a fat injection, decreased over time as a result of fat resorption. Nevertheless, this resorption remains extremely moderate in comparison with data from recent studies obtained with classically used techniques. With lipofilling, we achieved a 70.9% maintenance of projection at 5 months compared with the level of projection at 15 days after surgery. Clearly, there is a flattening of the absorption curve from the third month (Fig. 2), which is coherent with other data in the literature.[24,25]

Breast lipofilling has been the subject of a large number of studies over the last 20 years. Although, to date, no technique has yet to be adopted universally, a consensus is emerging in the literature

as to the steps and rules that should be respected when collecting and processing fat. These include the following:

The respect of a minimal vacuum during lipoaspiration to limit cell trauma.[10]

The use of a small-diameter cannula with small-diameter holes, enabling the harvesting of small-diameter adipose lobules, which will be more easily vascularized.[11,26]

The carrying out of multiple washings that enable inflammatory molecules and cell death factors linked to lipoaspiration to be eliminated.[12,13,16]

Centrifugation conducted at moderate speeds to preserve adipocyte membrane integrity.[14,15]

CONCLUSION

In conclusion of this study, we demonstrate that, by following a specific protocol that addresses the aforementioned precautions and recommendations, while using material that is specifically adapted, it is possible to obtain a satisfactory level of fat survival, even in the clinically unfavorable case of postirradiation DIEP breast reconstruction.

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