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Reconstructive

Autologous Fat Grafting Restores Soft-tissue Contour Deformities after Vascular Anomaly Surgery

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Background: Soft-tissue loss is expected after resection of large vascular lesions. Autologous fat transfer improves asymmetries; however, systematic outcomes are not previously described for vascular anomaly reconstruction.
Methods: Retrospective chart review from 2012 to 2015 included patients receiving autologous fat transfers for soft-tissue defects during or following vascular anomaly surgery at a tertiary care center. Patients received dermal en bloc fat grafts, lipoaspirates, or both. Pre- and postoperative photographs were blindly reviewed by 3 facial plastic surgeons using a 5-point scale. Dermal abdominal en bloc fat grafts were placed immediately after excision of a vascular anomaly. Lipoaspirate fat grafting was performed using liposuction (modified Coleman technique) and centrifugation. The effectiveness of fat transfers was assessed using patients' photographs. Final follow-up was 6 months to 5 years.
Results: There were 35 autologous fat transfer surgeries in 27 patients. Fourteen patients received en bloc dermal fat grafts (14 total), 13 lipoaspirate transfers (21 total), and 3 both. Ages ranged from 2 to 69 years (mean = 25 years). Majority of patients (81%) had head and neck lesions. Average volume of fat injected was 16.5 mL (range 0.8–100 mL). The average observer rating score was 2.45 [1–5 (5-point scale)] in the en bloc fat graft group versus 3.83 in the lipoaspirate group ($P < 0.0001$) with acceptable inter-rater reliability between 3 observers (coefficient of concordance = 0.76). Follow-up ranged from 6 months to 5 years. There were 2 complications in the dermal fat graft group and none in the lipoaspirate group.
Conclusions: Autologous fat transfer improves symmetry and scarring after surgical treatment of vascular anomalies. Fat grafting is permanent and reliable and creates a more symmetric soft-tissue contour compared with dermal fat grafts. *(Plast Reconstr Surg Glob Open 2019;7:e2196; doi: 10.1097/GOX.0000000000002196; Published online 16 May 2019.)*

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INTRODUCTION

Vascular lesions often involve all layers of soft tissue, including skin, subcutaneous fat, muscle, and even bone. They may be very localized or span several anatomic subsites. The management is multidisciplinary, with surgery an important treatment modality.[1]

Surgical excision of a vascular tumor or malformation may cause a soft-tissue contour deformity. In some cases, one facial "deformity" is traded for another. Autologous fat transfer has been described over the past century[2] and has become widely accepted since 1980s. With the advent of centrifugation and processing techniques popularized by Dr. Sydney Coleman,[3,4] fat is now accepted as the ideal filler. Fat grafting has been used in all manner of soft tissue augmentation or reconstruction, including facial and breast contouring, scarring from radiation, surgery, trauma, or burn, as well as con-

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genital anomalies.[5–11] Compared with other allogeneic or artificial reconstructive options, autologous fat grafts have several beneficial characteristics, including lack of immunogenicity, source of stem cells, simple surgical procedure, low cost, and easy accessibility.[12–14] Past studies have also shown improvement in overlying scar texture after fat injection.[15]

Fat grafting has been previously described for structural facial anomalies.[16] This is the first known experience of autologous fat grafting for the correction of surgical soft-tissue defects after congenital vascular anomaly resection in children and adults.

METHODS

We performed a retrospective chart review (notes and photos) of patients receiving autologous fat transfers to correct a soft-tissue deformity after vascular anomaly excision from 2012 to 2015. Demographic information including patients' age, and sex were recorded. The anatomic location of the defect, type of vascular anomaly removed, harvest method and transfer technique, fat volume, duration of follow-up, and complications were noted. Clinical photographs were reviewed.

The types of vascular lesions included vascular tumors [infantile hemangioma (IH)] or malformations (venous, glomuvenous, lymphatic, arteriovenous). There were 32 autologous fat transfers consisting of 14 en bloc dermal fat grafts and 16 autologous lipoaspirate grafts in a total of 30 patients.

The differing methods of fat harvest and grafting techniques are outlined below.

Dermal En bloc Fat Graft Harvest and Transfer

An autologous dermal fat graft involved removal of whole adipose tissue with a partial dermal graft from the suprapubic abdomen with sharp dissection and direct transfer to the soft-tissue defect. This occurred either concurrent with or after removal of the vascular anomaly. The graft was secured in several places to the surrounding tissues with absorbable suture and the overlying skin flap was replaced over the area.

Lipoaspirate Harvest and Transfer

Fat harvest for fat injections involved the modified Coleman technique.[3] Fat is harvested via liposuction, typically from the patients' upper bilateral medial thighs or abdominal area. Stab incisions of 2–3 mm are marked in the umbilicus (for abdomen) or groin (for medial thigh) and the area is injected with 1% lidocaine and 1:100,000 of epinephrine. Using these incisions, tumescent solution (adult dose: 500 mL of lactated Ringer's solution, 50 mL of 1% lidocaine, 1.25 mg of epinephrine 1:1,000; children's dose: 250 mL of lactated Ringer's solution, 12.5 mL of 1% lidocaine, 0.3 mg of 1:1,000 epinephrine) at a volume equal to the amount of fat to be harvested is injected into the subcutaneous fat layer. After 15 minutes, the fat is harvested with 20-mL syringes with hand suction. In the case of larger volumes, a suction-assisted liposuction was performed. Once the fat is harvested, the fat is spun in a sterile centrifuge at g-force = 1006.23*g* for 3 minutes to separate the fat into supranatant (oil), subnatant (serum), pellet, and fat layers. After draining the lower plasma layers, and wicking off the oil, a 2-way adaptor is used to transfer the fat into 1-mL syringes.

Lipoaspirate Technique

At a distance of 1–2 cm from the soft-tissue defect, 3-mm stab incisions are marked. The tissues to be infiltrated and the incision sites are then injected with 1% lidocaine and 1:100,000 of epinephrine for hydrodissection, vasoconstriction, and hemostasis. Blunt 2-mm cannulas are used to inject the processed fat in overlapping layers within the subcutaneous fat plane. The area was visually overcorrected by 10%–20% to account for partial resorption.

En Bloc Fat Graft and Lipoaspirate Groups

Pre- and postfat transfer surgery clinical photos were evaluated by 3 facial plastic surgeons not involved in the direct care of the patient. Each patient's anatomical symmetry was ranked on a 5-point scale from 1 to 5 as follows:

1: no improvement
2: minimal improvement
3: moderate improvement
4: almost complete symmetry
5: complete anatomical symmetry

Scar Revision

Scar revision was performed with direct elliptical excision of the scarred skin into the subdermal subcutaneous fat layer. Soft-tissue flaps were then elevated in the subcutaneous plane with sharp dissection a few millimeters laterally to facilitate a tension-free closure. Buried 5-0 monocryl was used for the subcutaneous plane and 5-0 or 6-0 simple interrupted nylon sutures were used for the skin. The wound was then covered with mastisol and steri strips. The open scar revision occurred at a timepoint 1–2 months before any lipoaspirate transfer.

Statistical Analysis

Patient data including demographics, vascular malformation type, and method of fat transfer were collected and analyzed. The symmetry ratings were calculated as an average of scores from 3 raters. Mean scores after en bloc fat grafting were compared with mean scores after lipoaspirate fat grafting using *t* test of independent samples. The rating scores were compared between 3 raters using Kendall's coefficient of concordance method to determine the inter-rater reliability of the rating scale. All statistical analyses were completed using IBM SPSS version 23.

RESULTS

A total of 27 patients underwent 35 autologous fat transfer surgeries. Fourteen patients received en bloc dermal fat grafts (14 total grafts), 13 lipoaspirate grafts (21 total injections), and 3 both. The patients ranged in age

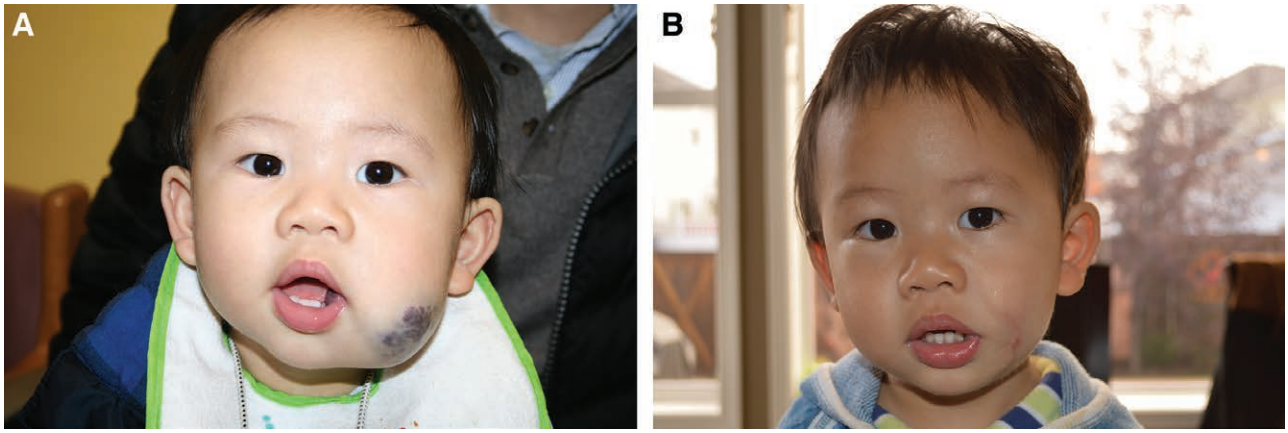

Fig. 1. A, One-year-old boy with history of left premandibular and buccal venous malformation. Lesion is transpatial across all tissue layers (dermis to buccal mucosa). B, Eight months after simultaneous excision and reconstruction with dermal en bloc fat graft.

from 2 to 69 years (mean 25 years) with a female-to-male ratio of 2.4:1.

The majority of patients (81%) had head and neck vascular anomalies, whereas 19% were of other anatomic subsites (4 arms and 1 buttocks). The average volume of fat injected was 16.5 mL (range = 0.8–100 mL). The average observer rating score was 2.45 (1–5 scale, 61%) in the en bloc fat graft group versus 3.83 (94%) in the lipoaspirate group ($P < 0.0001$). There was acceptable inter-rater reliability between the 3 observers (coefficient of concordance = 0.76). Follow-up ranged from 2 to 5 years.

Dermal En bloc Fat Graft Group

There was 1 patient in the en bloc fat graft group receiving a total of 14 fat grafts: 9 were performed as immediate reconstruction after excision of the vascular malformation. The graft sizes ranged from 2×2 cm to 5×10 cm with thickness of 1–3 cm. Of the dermal fat graft transfers, 10 were to the patients' right or left cheek [after cheek (Fig. 1), masseteric or parotid excision], 1 was to the temporal region (Fig. 2), and 1 was to the upper chest/shoulder region. Three patients required further lipoaspirate injections.

Overall, there were 2 complications in the en bloc fat graft group. The grafts were placed during the same operative procedure as the excision. These complications were secondary to the vascular anomaly surgery and not the actual reconstruction. There was an hematoma after excision of venous malformation of the masseter and salivary fistula after excision of a parotid venous malformation after which the grafts did not survive. These 2 patients benefitted from subsequent fat injections (Fig. 3).

Fig. 2. A, Adult woman after excision of right temporal venous malformation (frontal and basal views). Note scalloped defect of right temporal region. B, Six months after simultaneous excision and placement of dermal en bloc fat graft.

Fig. 3. A, Young woman after excision of right total parotid venous malformation. Dermal fat graft failed secondary to salivary fistula (frontal and oblique views). B, One year after 2 fat injections. Note improved soft-tissue contour, however, still with slight depression.

Lipoaspirate Group

There were 13 patients who received a total of 21 fat injections. Anatomically, 16 were to the patients' face, including the cheek, lip, temporal region, and forehead, 4 were to the right or left arm, and 1 was to the buttocks. Three patients with failed or insufficient en bloc fat grafts underwent lipoaspirate injections at a later date (Fig. 3). The majority of patients (22) had 1 injection, 4 had 2 injections, and 1 had ≥3 injections. The volumes of fat injected ranged from 0.8 to 100 mL. There were no complications in the lipoaspirate group such as wound infections, emboli, skin necrosis, nodule formation, or loss of sensitivity.[3] In all cases of fat injection, there was some improvement in contour, scar texture, or both.

All patients undergoing fat injection had improvement with complete symmetry or near symmetry (Figs. 4 and 5). Overall, the scores were higher for the lipoaspirate group and this was statistically significant ($P < 0.001$). There was acceptable inter-rater reliability between the 3 observers (coefficient of concordance = 0.76). The follow-up period of 2–5 years allowed permanent results.

DISCUSSION

Vascular anomalies often replace and distort normal anatomic structures. Surgical excision of these lesions may

Fig. 4. A, Young woman after excision of right malar cheek lymphatic malformation (frontal, oblique views). Note prominent depressed right nasojugal fold (black arrow is perpendicular to groove). B, Eight months after second fat injection with improved symmetry. Injections performed at 6-month intervals.

leave a soft-tissue defect leading to facial or body asymmetry. In addition to this, some IHs involving skin and subcutaneous tissue will also leave scarred and/or atrophic skin in their wake.

Reconstructive options for these defects include implants, allografts, or autologous materials. Autologous materials including fascia, or local or free tissue transfers are preferred because they have no immunogenicity and

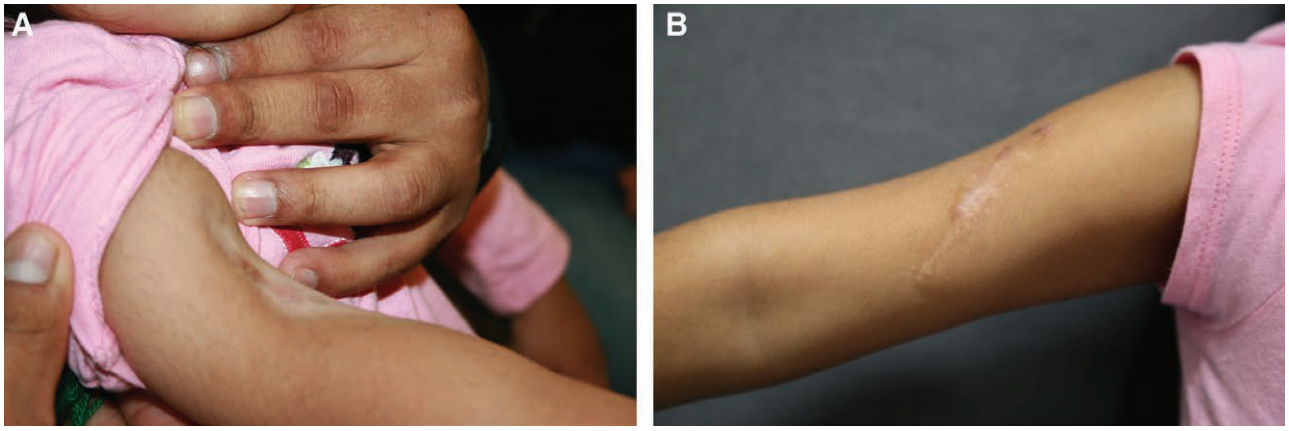

Fig. 5. A, Right upper arm hypopigmented skin and hollowed soft-tissue defect after excision of infantile hemangioma followed by intralesional steroid injection for hypertrophic scar. B, Three years after scar revision followed by 2 autologous fat injections.

Table 1. Fat Rating Statistics Displayed

	Observer 1		Observer 2		Observer 3	
En bloc Grafts	**En bloc Graft**	**Lipoaspirate**	**En bloc Graft**	**Lipoaspirate**	**En bloc Graft**	**Lipoaspirate**
1	2		2		2	
2	**2**		2		3	
3	1		1		3	
4	2		3		2	
5	1		1		3	
6	1		4		4	
7	3		3		4	
8	3		4		3	
9	4		3		4	
10	4		4		4	
11	1		2		3	
12	1		1		4	
13	1		2		1	
14	1		1		3	
Lipoaspirates						
1		5		5		4
2		4		2		3
3		3		3		4
4		2		4		3
5		2		4		4
6		4		5		4
7		4		4		4
8		3		4		4
9		5		5		4
10		4		4		5
11		5		3		4
12		5		4		4
13		2		2		3
14		4		4		4
15		3		4		4
16		5		5		4
Legend						
Ranking (qualitative): 1 = no change; 2 = minimal improvement; 3 = moderate improvement; 4 = almost symmetrical; 5 = complete symmetry						
En bloc grafts = 14						
Lipoaspirates = 16 (3 had failed fat grafts)						
Grafts and injections = 3 (evaluated at various points in time)						
Average score for en bloc patients (n = 14)				2.45238095		SD = 0.853
Average score for lipoaspirate patients (n = 16)				3.83333333		SD = 0.759
$P = 0.000113$						

higher acceptance rate at the graft site. For many patients, fat is an ideal autologous replacement material. There is an abundant supply; no added cost for the material, minimal morbidity and can be sculpted into the defect. Unlike synthetic fillers such as hyaluronic acid which resorbs over time, fat has permanence. Most importantly, fat is a source of mesenchymal stem cells with regenerative potential.[14] Previous studies have shown that fresh lipoaspirates have mesenchymal stem cells and growth factors, such as basic fibroblast growth factor (b-FGF), insulin-like growth factor-1, vascular endothelial growth factor, platelet-derived growth factor (PDGF-bb).[12] Histologically, there is evidence of neoangiogenesis, local vessel formation, and improved microcirculation. This leads to improvement in scars and skin rejuvenation. Previous histological studies in nude mice have shown thickening of the dermis secondary to an increase in density of the collagenous framework.[17] Our study also noted improvement in the overlying scar.[18]

We compared the use of autologous dermal en bloc fat grafts with lipoaspirate fat grafts in patients with defects after surgical removal of vascular anomalies. Our results show that lipoaspirates were superior and associated with no complications. We also noted improvement in the aesthetic contour and in the scar after fat transfer. The only disadvantage of lipoaspirates is that they may need to be repeated to optimize results. The procedure is reproducible, can be used in children and adults, has minimal morbidity, and is well tolerated.

The limitations of this study include the broad range of soft-tissue defect locations. For example, we included head and neck (majority) as well as peripheral lesions. Our practice is restricted to the treatment of vascular anomalies in children and adults, the removal of which often leaves defects. The common denominator is the defect created by the removal of the vascular lesion. Regardless of the anatomic location of this defect, our primary goal was to show how these defects can be corrected with autologous fat grafts. Although it is true that fat grafts do not readily take in some locations of increased mobility, it is still a viable option. Another limitation is the timing of the en bloc fat graft. These were placed

concurrent with a vascular anomaly excision. Thus, hematoma or salivary fistula was a complicating factor for the take of the graft.

CONCLUSIONS

Lipoaspirates are superior to fat grafting in the correction of soft-tissue contour deformities after surgical excision of vascular anomalies. This method is safe and effective in recreating symmetry and improving surgical scars in children and adults. We demonstrate that this approach has lasting results and can be easily and noninvasively repeated.

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The Authors have read and abide by the Declaration of Helsinki for the ethical treatment of patients and research subjects.

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