

Body Contouring

Preliminary Report

Calf Augmentation and Reshaping with Autologous Fat Grafting

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Aesthetic Surgery Journal
2015, 1–10
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DOI: 10.1093/asj/sjv166
www.aestheticsurgeryjournal.com
OXFORD
UNIVERSITY PRESS

Abstract

Background: Despite multiple advantages of fat grafting for calf augmentation and re-shaping over traditional silicone calf implants, few reports have been published.

Objectives: To report our technique and results with autologous fat grafting for calf augmentation and reshaping.

Methods: A retrospective review of the senior author's (JEV) experience with autologous fat grafting for calf augmentation was performed. Medial and lateral calf augmentation was accomplished with injection of prepared autologous lipoaspirate intramuscularly and subcutaneously.

Results: Over a 5-year period, 13 patients underwent calf augmentation and reshaping with the described technique. Ten cases were bilateral (77%), and 3 cases (23%) were performed for congenital leg discrepancies. Mean 157 cc of prepared lipoaspirate was transferred per leg, with roughly 60% and 40% transferred into the medial and lateral calf, respectively. Four patients (31%) underwent a second round of autologous fat injection for further calf augmentation because they desired more volume. At mean 19.6 month follow-up, durable augmentation and improvement in calf contour was documented by comparison of standardized preoperative and postoperative photographs.

Conclusions: Autologous calf fat grafting is a viable alternative to traditional implant-based calf augmentation for congenital calf discrepancies and the aesthetic pseudo-varus deformity. This technique provides results comparable to those obtainable with traditional methods.

Level of Evidence: 4

Accepted for publication July 16, 2015.

Advancements in plastic surgery are often made through the application of existing principles and techniques to a problem or area of the body where they had not previously been considered. The use of autologous fat grafting for calf augmentation and reshaping is one such application.

The slender, unaesthetic calf, which we frequently consider contributes to a “pseudo-varus” lower leg appearance (Figure 1), can be a source of unhappiness for men and women alike. Correction of slender unaesthetic lower legs, either for purely cosmetic purposes, or for discrepancies in appearance between legs due to congenital deformities, infections, or trauma, is an increasingly expressed patient desire.¹ Silicone calf implants have most frequently been used for this purpose, but carry risks of well-documented and frequent complications, including hyperpigmentation,

seromas, extrusion, infection, capsular contracture, removal for cosmetic dissatisfaction, and compartment syndrome.²⁻⁵

Fat grafting has revolutionized the conceptualization and treatment of contour and soft-tissue volume issues, and offers safe, durable outcomes with diminished scar burden compared to traditional filling techniques.^{6,7} Fat grafting for correction of unaesthetic calves would seem to be an ideal alternative to traditional calf aesthetic procedures, especially

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Figure 1. The pseudo-varus deformity in a 52-year-old woman. (A) Frontal, (B) left anterior oblique, (C) lateral, and (D) posterior views. Despite subjectively normal knee joint angles and lack of tibial bone growth discrepancies, the patient's legs appear to be in a varus (bow-legged) relationship. This is due to a relative excess of medial knee subcutaneous tissue, relative lack of calf volume (with more medial deficiency than lateral deficiency, though both lack relative volume), and poorly defined lateral calf contour below the popliteal crease.

considering the risks of silicone calf implantation, yet surprisingly few reports on the use of autologous fat injection for correction of unaesthetic calves have been published.⁸⁻¹¹

The purpose of this paper is to report the senior author's (JEV) experience with autologous fat grafting for augmentation and reshaping of unaesthetic calves. Key points for adequate assessment and correction with this technique are highlighted.

METHODS

Records of the senior author (JEV) were reviewed and patients undergoing calf augmentation with fat grafting were identified. Between April 2010 and February 2015, 13 consecutive patients underwent calf augmentation and

reshaping with fat grafting. Patient records, including preoperative and postoperative photographs, were evaluated at last follow-up and compared to preoperative imaging. Informed consent was acquired from all patients. Institutional research board approval for this study was not obtained, as these patients were seen in the senior author's private clinic.

Fat harvest was performed as follows: fat harvest sites were infiltrated with liposuction tumescent fluid consisting of 1 L of lactated ringer's, 30 mL of 1% lidocaine, and 1 ampule of epinephrine at a concentration of 1:1000 to turgidity of the harvest site (tumescent liposuction). Three and 4 mm accelerator tip cannulas were used for fat harvest. Fat was variably harvested from the abdomen, lateral thigh, medial thigh, waistline, flanks, axilla, upper back, and hips. Irrespective of fat harvest site, liposuction was also performed at the medial



Figure 2. Posterior (A) and anterior (B) markings for calf lipoinjection with differential placement of medial and lateral fat in a 52-year-old woman.



Figure 3. Technique for calf lipoinjection in a 40-year-old woman. Lateral injection of prepared fat through a single incision. (A) Medial injection of prepared fat through superior (B) and inferior (C) incisions.



Figure 4. (A, C, E) Preoperative and (B, D, F) 16.6 month postoperative (11.5 months after secondary fat grafting to the right calf) views of bilateral calf fat grafting in a 65-year-old woman with pseudo-varus deformity. 240 cc of prepared fat was injected into each calf. The patient desired further augmentation of the right calf, and underwent a second round of fat grafting to the right calf 5.1 months after her initial surgery. 84 cc of lipoaspirate was transferred during this secondary procedure.

knee to improve calf contour. Fat was collected into a sterile glass container, and sterilely transferred to a strainer, where excess tumescent solution and blood were separated from the fat.

Separated fat was then transferred to 10 cc syringes for injection into the calves. Incision sites were 1 to 2 mm in length and created with 14 gauge Nokor needles (Becton, Dickinson, and Company, East Rutherford, NJ). Lipoinjection was performed with a 21 cm, 2 mm fat transfer needle attached to the 10 cc fat-containing syringe. Typically two calf incisions (superior and inferior) were utilized for lipoinjection (Figures 2 and 3). Injections were first performed directly into the calf muscles and then into the subcutaneous calf tissue. Fat volume was judged to be sufficient when the calf was minimally firm but not tense. Volume was added to the lateral and anterior compartments when judged to be deficient and clinically indicated.

All procedures were performed under intravenous sedation with local anesthesia. All patients were positioned supine or in a decubitus position only. No patients were positioned prone as this approach is not used during intravenous sedation in our practice. Incisions were closed with a single absorbable 6-0 fast suture. Marcaine 0.25% was pre-injected into lateral and medial gastrocnemius muscles to provide pain relief postoperatively and to encourage early ambulation. The local anesthesia was injected prior to fat transfer to utilize the smallest amount of effective anesthetic volume and to precisely place it into the muscle. Additionally, this sequence may result in a less sedation and more rapid postoperative recovery.

Compression garments were not used in the areas of fat grafting in the immediate postoperative period, nor were compression boots. No patients were placed on anti-platelet medication. All were well hydrated intraoperatively. All



Figure 5. (A, C) Preoperative and (B, D) 46.4 month postoperative views of bilateral fat grafting in a 40-year-old woman. 168 and 180 cc of prepared lipoaspirate were injected into the right and left calf, respectively.

patients were encouraged to ambulate the day of surgery and daily thereafter. Starting on postoperative day 5, patients were asked to wear support stockings to provide relief from leg swelling. They were asked to continue this practice for three months after surgery. Sports and exercise were permitted as tolerated. Patients were evaluated initially at 2 weeks following surgery and then at regular intervals.

RESULTS

Mean patient age was 45 years (range, 29 to 65 years). Ten patients (77%) were women. Seven patients (54%) were African-American. Medical comorbidities included hypertension in 3 patients (23%) and atrial fibrillation in one patient (8%). Ten patients (77%) underwent bilateral calf augmentation. Three cases (23%) were performed for calf

asymmetries associated with congenital anomalies (spina bifida, club foot, and tethered spinal cord). No patient had prior cosmetic procedures involving the calves.

Mean operating time was 106 minutes (range, 75 to 165 minutes). Fat was harvested variably from the lateral thigh, medial thigh, medial knee, flanks, upper and lower abdomen, upper back, waistline, and/or hips. Mean lipoaspirate volume harvested per procedure was 1307 cc (range, 84 to 4500 cc), and mean fat volume transferred per leg was 157 cc (range, 78 to 330 cc). On average, 58% of transferred fat was placed into the medial calf, and 42% was placed into the lateral calf. Four patients (31%) desired further calf volume and underwent a second round of fat grafting. A mean of 155 cc (range, 84 to 200 cc) of fat was transferred to each leg during these secondary procedures.

Mean follow-up was 19.6 months (range, 3.5 to 53.2 months), and median follow-up was 13.7 months. Eight



Figure 6. (A, C) Preoperative and (B, D) 18.2 month postoperative views of bilateral fat grafting in a 48-year-old man. 130 cc of prepared lipoaspirate was injected into each calf (50 cc medially, and 80 cc laterally).

Table 1. Individual Patient Demographic, Procedural, and Follow-up Information

Patient NO.	Age (years)	Gender	Ethnicity	Comorbidities	Etiology of Calf Deformity	Laterality of Augmentation	Follow-up (months)	Complications	Second Round of Augmentation
1	41	Male	Caucasian	None	Tethered spinal cord	Right	53.2	None	Yes
2	52	Female	African-american	Hypertension, atrial fibrillation	Cosmetic	Bilateral	30	None	No
3	40	Female	African-american	None	Cosmetic	Bilateral	46.4	Incisional hyperpigmentation	Yes
4	29	Female	Caucasian	None	Cosmetic	Bilateral	4.1	None	No
5	29	Female	African-american	None	Right club foot	Right	12.4	Incisional hyperpigmentation	No
6	41	Female	Arabic	None	Cosmetic	Bilateral	34	None	No
7	65	Female	African-american	Hypertension	Cosmetic	Bilateral	16.6	None	Yes
8	56	Female	African-american	None	Cosmetic	Bilateral	10.2	None	No
9	48	Male	African-american	None	Cosmetic	Bilateral	18.2	None	Yes
10	46	Male	African-american	Hypertension	Spina bifida	Right	3.5	None	No
11	35	Female	Arabic	None	Cosmetic	Bilateral	13.7	None	No
12	43	Female	Caucasian	None	Cosmetic	Bilateral	4.6	None	No
13	33	Male	Hispanic	None	Cosmetic	Bilateral	8.4	Incisional hyperpigmentation	No

patients had follow-up greater than 12 months, and 4 patients had follow-up greater than 24 months. All patients achieved durable improvement in calf volume, shape, and contour, and agreed that fat take was evident (Figures 4-6 and Supplemental Figures S1 and S2). There were no infections. Three patients (23%) with dark skin tone complained of hyperpigmentation of the injection sites but at follow-up beyond 8 months, 2 of the 3 patients indicated these areas of hyperpigmentation were no longer a concern. Patient demographics and results are presented in Table 1.

DISCUSSION

As our series illustrates, both men and women, may request calf augmentation for a number of reasons. We have found these reasons generally stem from leg discrepancies resulting from congenital disease or trauma, or an overall dissatisfaction with the shape and appearance of their legs in the absence of underlying disease.^{9,10} In the former, patients are most concerned with augmentation of one calf, while they generally request augmentation of both calves in the latter, though this is not always the case.

For patients desiring calf augmentation, silicone calf implants have been the most widely applied modality.

Although high rates of patient satisfaction have been noted by specific authors, implants carry well described risks, including those related to long-term implantation of foreign bodies.²⁻⁵ Autologous fat augmentation offers a number of advantages over calf implants, including liposuction in adjacent areas to improve calf contour, smaller incisions, additional augmentation through subsequent fat grafting, durable results, lack of foreign body reaction, and precise patient-specific adjustments not possible with off-the-shelf implants.

Despite the marked increase in autologous fat injection procedures for other areas of the body, little has been written regarding calf augmentation with fat grafting.⁸⁻¹¹ Additional articles have cursorily mentioned fat grafting without description of technique, and have failed to provide adequate preoperative photographs for critical evaluation of results.^{5,12} The first and largest published series describing a technique for autologous calf augmentation with fat injection⁸ has furthermore been criticized for un-persuasive results.³ Similar results with combination endoscopic fascial release, calf implantation, and fat grafting are equally underwhelming.¹³

The plastic surgery literature is replete with conceptualizations of the “ideal” leg, especially for women, and

multiple methods for classification of calf deficits have been published. (Figures 7 and 8).^{1,14,15} These evaluations broadly consider the degree of soleus, gastrocnemius, peroneus longus, and flexor digitorum longus muscle underdevelopment, which contributes to medial, lateral, and/or posterior hypoplasia.¹⁴ Multiple ratios of leg length to calf length, ideal calf circumference, and ideal location of maximal calf projection have been published.^{1,11,14,15}

We feel that these classification systems are cumbersome in clinical practice, and find that most patients without congenital issues present with the pseudo-varus deformity (Figure 1). These patients appear to be bow-legged despite subjectively normal knee and tibial alignment without a history of leg growth discrepancies. We feel that augmentation of both the medial and lateral compartment with fat is critical to success, as both areas lack appropriate volume, definition, and aesthetically pleasing contour. Previously

described techniques that augment the lateral aspect of the calf^{9,10} have superior results, in our opinion, to those where only medial augmentation was performed.^{8,11,13} In clinical practice, patient satisfaction is a crucial determinant of procedural success. In our experience, most patients were satisfied with one round of calf fat grafting, although 29% (4 patients) desired further augmentation. We feel that excellent results can be obtained in one procedure. This appears to be congruous with practice patterns of those authors who augment the lateral calf,^{9,10} as opposed to those who do not.^{8,13}

Critical to patient satisfaction is an anatomic discussion outlining the location of the calf musculature and where augmentation is recommended. Often patients request augmentation of not only the gastrocnemius muscle but also the lower leg and even upper ankle region. It has not been our practice to inject fat primarily into these areas



Figure 7. The “ideal” male calf as demonstrated by at 59-year-old subject. (A) Anterior, (B) anterior contracting, (C) posterior, and (D) posterior contracting views. The medial calf (gastrocnemius muscle) has a lower bulge or prominence than the lateral calf. The gastrocnemius muscles themselves end at the mid-tibia and thus augmentation ought to also end or taper off at this point. Anteriorly the lateral calf bulge begins at the lower margin of the patellar tendon insertion and the medial calf bulge begins about 1 to 2 cm lower than the lateral bulge. The medial gastrocnemius is generally, but not always, larger and fat grafting should be done to provide balance with the rest of the leg musculature and in accordance with the missing muscle mass as individualized for each patient.

because of the unforgiving nature and perceived low likelihood of fat “take” in these lower leg tissues, although some fat grafting in these immediately surrounding tissues is performed to provide contour blending. Additionally, and especially in women, it is important to consider the shape of the entire upper and lower leg to create a balanced and harmonious leg/calf contour. Specifically, liposuction of the medial and lateral thigh as well as the inner knee area alone improve the pseudo-varus appearance of the lower leg. When directed calf augmentation is added to this more global contour approach, the result is objectively and well received by the patient (Figures 4 and 5).

It has been our practice to over-augment by approximately 10%-15%. This is an arbitrary estimate of the over-fill volume and perhaps a more aggressive fill, such as the

20%-30% over-augmentation described by Hoppmann et al,¹¹ would have eliminated the need for a second procedure in those patients that requested additional surgery. On the other hand, the calf becomes quite tense with a surprisingly small volume of fat injection. Concern for increased pain and excessive pressure impairing the fat take are other factors we consider with the judgment of final utilized volumes. The pre-grafting injection of Marcaine (10 to 15 cc/muscle, 0.25% with epi 1:200,000) has been an excellent method to reduce postoperative pain and permit ambulation upon discharge.

Limitations of this study include its retrospective nature and lack of objective calf measurements. Patient satisfaction was also not objectively assessed. This technique may be less applicable for younger patients with



Figure 8. The “ideal” female calf as demonstrated by a 32-year-old subject. (A) Anterior, (B) anterior contracting, (C) posterior, and (D) posterior contracting views. Similar to conceptualizations of feminization of other body parts, the calf also reflects this concept of balance and harmony with the rest of the body. Male calf muscles are ideally more bulky or defined and prominent compared to the softer curves of the female calf.

more taught tissues, and its use has not been explored in bodybuilders. Four months was considered a stable result and this was verified by the long-term follow-up reported in this article.

CONCLUSIONS

Autologous calf fat grafting is a viable alternative to traditional implant-based calf augmentation for congenital calf discrepancies and the pseudo-varus deformity. This technique provides durable results that minimize patient risk. Lateral lipoinjection is a key component of effective correction and may provide results superior to those obtainable with traditional methods.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding

The authors received no financial support for the research, authorship, and publication of this article.

REFERENCES

- Howard PS. Calf augmentation and correction of contour deformities. *Clin Plast Surg*. 1991;18(3):601-613.
- Niechajev I. Calf augmentation and restoration. *Plast Reconstr Surg*. 2005;116(1):295-305.
- Niechajev I. Calf augmentation with autologous tissue injection. *Plast Reconstr Surg*. 2009;123(6):1891-1892; author reply 1892-3.
- Aiache A. Leg contouring with calf implants. *Clin Plast Surg*. 1996;23(4):737-749.
- Fracalvieri M, Contessa L, Salomone M, Zingarelli EM, Bruschi S. Preoperative color duplex echographical venous mapping before autologous fat graft for calf augmentation: a case report of superficial vein thrombosis and prevalence of intersaphenic anastomosis. *Ann Plast Surg*. 2014;73(2):137-140.
- Toledo LS, Mauad R. Fat injection: a 20-year revision. *Clin Plast Surg*. 2006;33(1):47-53. vi.
- Coleman SR. *Structural fat grafts: the ideal filler?* *Clin Plast Surg*. 2001;28(1):111-119.
- Erol OO, Gürlek A, Agaoglu G. Calf augmentation with autologous tissue injection. *Plast Reconstr Surg*. 2008;121(6):2127-2133.
- Veber M Jr, Mojallal A. Calf augmentation with autologous tissue injection. *Plast Reconstr Surg*. 2010;125(1):423-424; author reply 424-5.
- Mojallal A, Veber M, Shipkov C, Ghetu N, Foyatier JL, Braye F. Analysis of a series of autologous fat tissue transfer for lower limb atrophies. *Ann Plast Surg*. 2008;61(5):537-543.
- Hoppmann R, Meruane M, González D, Wisnia P, Hasbún A, Villalobos B. Calf lipo-reshaping. *J Plast Reconstr Aesthet Surg*. 2013;66(7):956-961.
- Matsudo PK, Toledo LS. Experience of injected fat grafting. *Aesthetic Plast Surg*. 1988;12(1):35-38.
- Karacaoglu E, Zienowicz RJ, Balan I. Calf contouring with endoscopic fascial release, calf implant, and structural fat grafting. *Plast Reconstr Surg Glob Open*. 2013;1(5):e35.
- Cuenca-Guerra R, Daza-Flores JL, Saade-Saade AJ. Calf implants. *Aesthetic Plast Surg*. 2009;33(4):505-513.
- Tsai CC, Lin SD, Lai CS, Lin TM. Aesthetic analysis of the ideal female leg. *Aesthetic Plast Surg*. 2000;24(4):303-305.