Lipo Definition in Thighs: Volumizing and Defining the Vastus Muscles by Fat Transfer

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Background: Volumizing muscles in the thighs by fat grafting to complement body contouring surgeries has not been adequately investigated. Our objective was to describe a technique (VDVFAT) that defines and volumizes thigh muscles by lipotransfer in the vastus medialis and vastus lateralis muscles.

Methods: VDVAT was performed in 52 patients by the same surgeon at a private clinic in Lima, Peru, between 2018 and 2019. All patients were aged between 18 and 60 years, had no cutaneous flaccidity of the thighs, had a body mass index less than 28, and had Goldman surgical risk below Class II.

Results: A total of 45 women aged 19–41 years (mean: 29.2 years) and seven men aged 24–41 years (mean: 33 years) were included. A mean of 173.36 cm³ of intramuscular fat was grafted to the vastus lateralis, resulting in increased muscle thickness of 21.09 mm, which is equivalent to 88.31% of the initial size of the muscle ($P < 0.0001$). An intramuscular fat mass of 123.53 cm³ was grafted into the vastus medialis, resulting in increased muscle thickness of 30 mm, which is equivalent to 87.02% of the initial size of the muscle ($P < 0.0001$).

Conclusions: Volumizing and defining the vastus muscles by fat transfer is a safe and reproducible method for defining and volumizing muscles. However, further studies are necessary to determine the durability of fat grafts. (Plast Reconstr Surg Glob Open 2021;9:e3945; doi: 10.1097/GOX.0000000000003945; Published online 29 November 2021.)
method in 1893.7 Subsequently, Illouz et al further studied and developed the technique, which is now well known.8–10 The muscle is a favorable choice for the reception and integration of fat grafts with a higher degree of survival; nevertheless, each muscle poses certain challenges specific to its characteristics, such as size, volume, and the presence of abnormal vessels that might interfere with fat injections.11 Hoyos and Perez reported a case series of intramuscular volumization using autologous fat in the deltoid muscles, which yielded acceptable results.2 Viaro et al published a similar study in which they infiltrated fat into the rectus abdominis using an ultrasound-assisted technique.1

Considering these previous studies, our study aimed to describe a modern technique used to define and volume the muscles of the thighs by lipotransfer to the vastus lateralis and vastus medialis, and by liposculpture of the different natural curves with controlled extraction of fat that provides dynamic enhancement of the different muscular structures of the thigh.

MATERIALS AND METHODS

After receiving approval from our local committee and adhering to the principles outlined in the Declaration of Helsinki for the study, all patients were asked to sign an informed consent form before performing the VDVFAT technique.

A prospective study was conducted among 52 patients (45 women, seven men) who underwent liposuction with thigh definition and volumization by intramuscular fat grafting in the vastus lateralis and vastus medialis (VDVFAT).

All patients recruited in this study visited the plastic surgery practice, seeking evaluation for undergoing body-contouring liposuction surgery. Similarly, all patients shared a common desire for an athletic appearance of their legs. Furthermore, the participants included patients who, despite their strenuous workouts at the gym, could not achieve the expected results.

The procedure was performed by the same surgeon in a private clinic in Lima, Peru, between 2018 and 2019. All patients met the following criteria: aged between 18 and 60 years, no skin flaccidity of the thigh, body mass index of 28 or less, and Goldman surgical risk below Class II. All patients recruited in this study visited the plastic surgery practice, seeking evaluation for undergoing body-contouring liposuction surgery. Similarly, all patients shared a common desire for an athletic appearance of their legs. Furthermore, the participants included patients who, despite their strenuous workouts at the gym, could not achieve the expected results.

The technique involved the use of a soft-tissue ultrasound specialist measured the thickness of the vastus lateralis and vastus medialis muscles before and after the surgical procedure (See Video 2 [online], which displays ultrasound measure). The measurements were recorded in a database. Statistical analysis was performed using SPSS version 25, and the data of ultrasound measurements before and after intramuscular fat grafting were analyzed using the Wilcoxon test.

Under general anesthesia, the patients underwent body-contouring liposuction surgery with the super-wet technique wherein normal saline and epinephrine with a 1:1,000,000 ratio were used. Subsequently, a period of 10 minutes was allowed before liposuction of the different areas for body contouring was performed with 4-mm and 5-mm Basket and Mercedes cannulas and a 160 mm Hg suction machine. The fat was collected in 2000 cm³ sterile vials after a 20-min decantation time.

We used the suprapubic incisions that were previously made during the abdominal liposuction to infiltrate the targeted areas for treatment in the thighs with normal saline and epinephrine at a 1:1,000,000 ratio. A period of 20 min was allowed to lapse before proceeding with lipomarking of the medial edge of the vastus medialis and vastus lateralis, which forms an inverted V, and of the anterior edge of the iliobibial band, depending on each patient’s unique preferences. Lipomarking of these anatomical areas was performed with superficial and deep liposuction using 4-mm and 5-mm angled and curved Basket and Mercedes cannulas that were 35–40 cm in length (Fig. 3).

A red line was drawn from the anterior superior iliac spine to the superolateral edge of the patella; the safe zone for fat injections in the vastus lateralis muscle are located in the lateral areas (Fig. 2). We used an 18-gauge needle for puncturing the skin, and used a 2-mm Coleman cannula to puncture the fascia and enter the intramuscular plane. This maneuver is performed by holding the vastus lateralis muscle in place using the nondominant hand and injecting the fatty tissue with 20 cm³ syringes using the dominant hand in continuous and antero-retrograde movements (See Video 3 [online], which displays VDVFAT procedure). This allows us to visually objectify the increase in the volume of the muscle being worked on (Fig. 4).

We determined the safe zone for the vastus medialis muscle by locating the superomedial edge of the patella. Further, the midline of the identified muscle was located with a green line (Fig. 2); so we could perform the same fat grafting technique used for the vastus lateralis in the
area lateral to this line. The vastus medialis was approximately less than 10 cm from this point (Fig. 4).

RESULTS

We recruited 52 patients who underwent body-contouring surgery that included VDFAT between 2018 and 2019. The patients included 45 women aged 19–41 years (mean: 29.2 years) and seven men aged 24–41 years (mean: 33 years) with a mean body mass index of 23.43. All patients experienced satisfactory recovery, and none developed postoperative complications (e.g., infection, thromboembolism, bleeding requiring blood transfusion, death). The mean surgical duration for liposculpture with muscle definition, excluding the thighs, was 120 min, and the mean aggregate duration for muscular fat grafting and marking of the thighs was 20 min (Table 1).

For volumization, intramuscular fat was grafted in the right vastus lateralis using the VDFAT technique with a mean of 168.50 cm³ of infiltrated fat. This revealed a 21.65 mm increase in muscle thickness upon immediate postoperative ultrasound, which was equivalent to an 85.60% \( (P < 0.0001) \) increase relative to the initial measurements (Table 2). The mean volume of fat grafted into the vastus lateralis was 173.36 cm³, resulting in an increase of 21.09 mm in muscle thickness; this was equivalent to 88.31% \( (P < 0.0001) \) of the initial muscle thickness (Table 2).

The same procedure was performed for the right vastus medialis. Intramuscular fat was grafted using the VDFAT technique, resulting in a mean of 118.46 cm³ of infiltrated fat. This revealed an increase of 29.38 mm in muscle thickness upon immediate postoperative ultrasound, which was equivalent to an 84.21% \( (P < 0.0001) \) increase relative to the initial measurements. Similarly, a mean of 128.6 cm³ of intramuscular fat was grafted into the left vastus medialis, revealing an increase of 30.63 mm in muscle thickness upon immediate postoperative ultrasound; this was equivalent to an 89.84% \( (P < 0.0001) \) increase relative to the initial measurements (Table 3). The mean volume of fat grafted into the vastus medialis was 123.53 cm³, resulting in an increase of 30.00 mm in muscle thickness; this was equivalent to an 87.02% increase relative to the initial measurements (Table 3).

The mean hemoglobin decrease 12 h after surgery was 2.13 mg per dl, which was equivalent to a decrease of 15.46% \( (P < 0.0001) \) relative to the mean beginning hemoglobin (Table 1).
**DISCUSSION**

When performing liposuction with muscle definition, it should be considered that this surgery aims to primarily achieve optimal results in terms of athletic anatomy; therefore, harmonization of the different muscle groups is important, including those comprising the upper limbs, back, abdomen, gluteal muscles, and lower limbs. However, all anatomical regions are not always considered, as liposuction is performed with muscle definition in the abdomen, thorax, and upper limbs with poor focus on their harmonization with the lower limbs. Providing adequate focus on the lower limbs is important, as its muscles lead to a visual effect that complements the athletic figure sought by muscle defining techniques during the surgical procedure. Performing muscle definition is similar to performing muscular exercise routines that target specific areas such as the anterior or posterior thorax, upper limbs, rectus abdominis, and oblique abdominal muscles with no focus on the lower limbs. This leads to a morphological aberration that creates a visual impression of having a wide muscle volume in regions wherein more contouring was done while other areas wherein less contouring was done appear asymmetrical in terms of volume. This is also known as “chicken leg syndrome” in the field of bodybuilding.

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**Fig. 3.** The vastus muscle. Lipomarking of the vastus internal (A, B) and the vastus external muscle (C, D).
Thigh definition surgery allows for the appropriate marking of muscle groups such as the vastus lateralis and vastus medialis. However, there might be patients who do not have adequate muscle size needed for the harmonious definition of the thighs. Muscle volume plays a fundamental role in this.

Different techniques are now used to volumize the thighs, which mainly include implanting silicone and grafting fat. These techniques were mainly initiated to correct deformities or to act as a complement of reconstructive surgeries for diseases such as poliomyelitis or injuries due to trauma. However, they have been adapted over time to improve the results of cosmetic surgery of the lower limbs.

In volumization by placement of silicone implants, two anatomical areas are used: (1) an anterointernal region in a natural concavity formed by the sartorius and adductor longus muscles and (2) an external region formed by the tensor of the fascia lata and sartorius. The ease of placement depends largely on the expertise of the surgeon;
Table 3. Change in the Dimensions of Vastus Medialis

| Variable                                    | Women                     | Men                       | Overall Mean |
|---------------------------------------------|---------------------------|---------------------------|--------------|
| Mean right vastus medialis fat graft (cm³)  | 100–160* (117.56†)        | 100–160* (124.29†)        | 118.46       |
| Mean change in the thickness of right vastus medialis (mm) | 29.44                    | 29.93                     | 29.38        |
| % change in the thickness of right vastus medialis | 83.51                    | 88.69                     | 84.21        |
| Mean left vastus medialis fat graft (cm³)   | 100–159* (130.27†)        | 103–134* (117.86†)        | 128.6        |
| Mean change in the thickness of left vastus medialis (mm) | 30.73                    | 30.00                     | 30.63        |
| % change in the thickness of left vastus medialis | 88.92                    | 95.75                     | 92.84        |
| Mean vastus medialis fat graft (cm³)        | 123.53                    |                           |              |
| Mean change in the thickness of vastus medialis (mm) | 30.00                    | 87.02%                    |              |

*Range of grafted volume.
†Mean volume.

however, the major challenge with this technique is the risk of injuring vascular nerve structures located in the Hunter’s canal, which is located deep in the anterointernal region where the implant is typically placed.14,15

Providing an athletic anatomical effect without the required muscle volume, the other technique for volumization uses subcutaneous fat grafting and presents good aesthetic results.6,8,15 Intramuscular fat grafting can achieve a harmonious, athletic visual effect that allows the patient’s grafted muscles to have an appearance of dynamic muscle development when they perform movements, which is already known in the case of the pectoral and deltoid muscles6 (Fig. 5).

In our study, the surgical technique for fat tissue collection was performed by liposuction in a manner similar to that described by Coleman,10,16 which is a precise, simple, easily reproducible,17 and safe technique with few complications.18 Based on our findings, we therefore propose an alternative technique of volumization for the thighs, which consists of intramuscular grafting in the vastus lateralis and vastus medialis to achieve volume according to the definition of our surgical plan and the anatomy of vascularization of the muscle groups to prevent adverse events such as muscle necrosis or fat embolisms.

In our bibliographic search, we could not find reports on surgical techniques for intramuscular grafting in the thighs, but those for other anatomical areas, especially the upper limbs, chest, and abdomen, were readily available.1,2,7 Hence, we prepared a surgical plan based only on anatomical knowledge but still considered muscle vascularization and important structures related to the areas worked on to reduce the risks of grafting.

According to Mathes and Nahai’s classification,20 the vastus lateralis is a type 1 muscle with a single pedicle supplied by perforants of the descending branch of the lateral femoral circumflex artery, whose path usually runs through the intermuscular septum of the vastus lateralis and rectus femoris muscles. It is identified by drawing a straight line from the anterior superior iliac spine to the superolateral edge of the patella.21 We recommend following this path and placing the intramuscular fat graft in an area lateral to this line and to the patella from bottom to top to prevent compromising its pedicle and potential complications (Fig. 2).

On the other hand, according to Mathes and Nahai,20 the vastus medialis is a type 2 muscle supplied by perforants from the branches of the superficial femoral artery, which runs through the Hunter’s canal and goes deeper and posterior in the distal hiatus; this is approximately 9 and 9.5 cm from the base of the patella in men and women, respectively, which is at the medial edge of the vastus medialis.14,15 Therefore, intramuscular fat grafting below this distance and near the midline of the muscle decreases the risk of fat embolism in the superficial femoral vessels (Fig. 2).

Considering these, we located specific and safe anatomical points to distally graft fatty tissue and achieve the visual effect of muscle volume (Fig. 2). In our procedures, we used blunt-tipped cannulas and preferred to apply fat grafts in the anteroposterior direction (Fig. 4).

One of the most concerning complications that can occur with intramuscular infiltration of fatty tissue is fat embolism. There are known cases of these events occurring when fatty tissue infiltrates the gluteus maximus muscle; however, vascular anatomy in the gluteal muscles is different compared with that of the other muscle groups; so intramuscular fat grafting can therefore be more safely performed.1,2

Fat embolism of the thigh is very rare compared with that of regions such as the gluteal area, where due to their large caliber, the lateral varicose veins associated with the piriformis muscle are more prone to injury due to the placement of fat into the deep muscular plane. Moreover, the negative pressure gradient in the injured gluteal vessels increases the risk of fat embolism.23,24 This phenomenon is not usually observed in the thigh, where perforating vessels are smaller and large vessels are located lateral or medial to the lipografting point described in our technique.

The additional time required for bilateral muscle definition and volumization of both vastus muscles was approximately 20–30 minutes, which was similar to that required for volumization by subcutaneous fat grafting and less than the time required for silicone implants.25,26

None of the patients developed adverse events such as embolism, muscle or fat necrosis, surgical site infections, or bleeding. One of the limitations of our work is the lack of an adequate follow-up period to assess the durability of the grafted fat. However, it is well known that the durability of the fat grafted in the intramuscular plane is higher than that of the one grafted outside this plane. A longer follow-up of these patients is required to obtain further information on the durability of the graft. (See figure 1, Supplemental Digital Content 1, PRS Global Open • 2021
which displays the patient before and 1 year after the procedure, wherein the female patient is seen in a standing position without muscle contraction. 

See figure 2, Supplemental Digital Content 2, which displays the patient before and 1 year after the procedure, wherein the male patient is seen in a standing position without muscle contraction.

**CONCLUSIONS**

The surgical technique for VDVFAT can be performed by intramuscular grafting as described in this article. It is a safe and reproducible procedure, which adequately complements the definition of muscle groups in terms of obtaining athletic and harmonious results. None of the patients in our study experienced adverse events, such as surgical site infections, thromboembolic disorders, fat embolism, and muscle necrosis. The increase in muscle volume quantified by ultrasound upon immediate postoperative period is evident; however, we need more information about the durability of fat grafts. Thus, more follow-up studies on patients who have undergone this technique are required to better understand their durability.

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