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Reconstructive

Influence of BMI, Age, and Gender on the Thickness of Most Common Thinned Flaps

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Background: Since the description of superficial fascia flap harvesting, a new window of opportunity has been open in obese patients, where a higher subcutaneous thickness of tissue is present. To our knowledge, the impact of body mass index on superficial fascial flaps has not been reported.

Methods: We recruited 122 patients from April 2019 to January 2020. From these patients, the 3 most common thinned flaps were selected: the superficial circumflex iliac perforator flap; the anterolateral thigh flap at the perforator A, B, and C; and the thoracodorsal flap. Two vertical measures were registered: the distance from the skin to the superficial fascia, and from this point to the deep fascia.

Results: The average flap measurement presented here was within the range, as previous clinical studies. The superficial fatty layer thickness in the superficial circumflex iliac perforator and anterolateral thigh flap was somewhat similar in thickness between overweight and obese patients, showing a minimal increase with higher body mass index. The anterolateral thigh flap was found thicker among women, and no statistical difference was shown between age groups in any of the flaps.

Conclusions: A better understanding of the fat layers' thickness will result in better planning, minimizing secondary debulking procedures, decreasing operative time, and reducing general complications among obese patients. Thus, a better understanding of flap structure and physiology in obese patients will lower complications and give more predictable results. *(Plast Reconstr Surg Glob Open 2021;9:e3409; doi: 10.1097/GOX.0000000000003409; Published online 30 March 2021.)*

INTRODUCTION

Obesity has tripled worldwide since 1975. In 2016, 39% of the world's adults were overweight, and 13% were obese.[1] These figures will continue to increase over the years; so, it is crucial to understand how obesity affects our field. Obesity has been linked to higher rates of infection and dehiscence. Moreover, studies have shown a slight but nonsignificant increase in flap loss (5.5–7.0 versus 2.6%) among other surgical complications.[1–3] Therefore, obesity has been considered a relative contraindication for free flap surgery.

Since the description of superficial fascia flap harvesting, a new window of opportunity has been open in obese patients, where a higher subcutaneous thickness of tissue is found. Although multiple cases of successful free flap reconstruction have been reported, no evidence of an altered pattern of circulation nor perforator anatomy has been revealed among these patients.[4]

To our knowledge, the impact of body mass index (BMI) on superficial fascial flaps has not been reported so far. However, because obese patients will still need reconstructive procedures, this study aimed to define the impact of age, gender, and BMI in the thickness of the superficial fatty layer (SFL) and deep fatty layer (DFL). With a better understanding of the fat layers' thickness, better planning will be achieved, minimizing secondary debulking procedures, decreasing operative time, and reducing general complications among obese patients.

MATERIALS AND METHODS

Our study was carried out prospectively at the department of plastic and reconstructive surgery, Hospital General Dr. Rubén Leñero, Mexico City, Mexico. A sample

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of 84 patients was calculated, although 122 patients were recruited from April 2019 to January 2020. All of the enlisted patients were assessed for soft tissue reconstruction of any kind (microsurgical and non-microsurgical) and were 18 years old or older. Exclusion criteria were patients with major amputations or with a BMI that could not be established; patients with previous surgeries or scars in the desired measuring areas; or those with any other pathology affected by the weight such as fat distribution, muscle mass, or bodily fluids. No outcomes will be presented in this study because not all patients underwent microsurgery reconstruction.

SONOGRAPHIC MEASUREMENTS

All sonographic measurements were taken with the same equipment, using a linear handheld 9.0 MHz probe (DP-20, Mindray China, Inc.). After the measurement point was established, 2 vertical measures were registered: the distance from the skin to the superficial fascia, and from this point to the deep fascia. A screenshot was taken, as shown in Figure 1. The demographic data, including sex, age, weight, height, and thickness of each flap, were registered using Microsoft Excel 2019 (Microsoft Corp., Redmond, Wash.).

- *Superficial circumflex iliac artery perforator* (SCIP): Usually, there are 1–3 perforators located in this region.[1] However, the measurement was made most frequently; the dominant perforator is situated at the cross point of a vertical line 3 cm medial from the anterior superior iliac spine, and through the line from the inguinal crease to the anterior superior iliac spine, as reported by Chuang et al[5] and Koshima et al,[6] as shown in Figure 2A.
- *Anterolateral thigh flap* (ALT): For this flap, 3 points of measurement were used. First, a line was drawn from the anterior superior iliac spine to the patella's superior lateral aspect. At the midpoint (24.3 cm ± 5.4 cm) of this line, our Point B was located, following Song et al.'s description.[7] After locating point B, markings of point A and point C were located at 11 and 9% proximal and distal of the total distance (5.4 cm ± 3.5 cm and 4.4 cm ± 3.3 cm) of this previous line. Measurements that were obtained from previous studies,[8] as exemplified in Figure 2B.
- *Thoracodorsal perforator flap* (TAP): After a line was drawn from the posterior superior iliac spine to the posterior axillary fold, the measurement was made 10 cm below the axillary fold, and 2 cm behind the lateral border of the latissimus dorsi muscle,[9] as shown in Figure 3.

STATISTICAL ANALYSIS

A descriptive analysis was performed using measures of central tendency and dispersion. To evaluate distribution, a Kolmogorov-Smirnov was made. The Wilcoxon and *t*-test were used to assess the parametric and nonparametric variables. A paired *t*-test and sign test was used to compare means between SFL and DFL. A factor analysis of variance test was performed to compare the means from the BMI groups tested, stratified according to the WHO guidelines. Pearson correlation analysis was performed for the parametric variables, whereas the covariance between BMI and age was analyzed using different

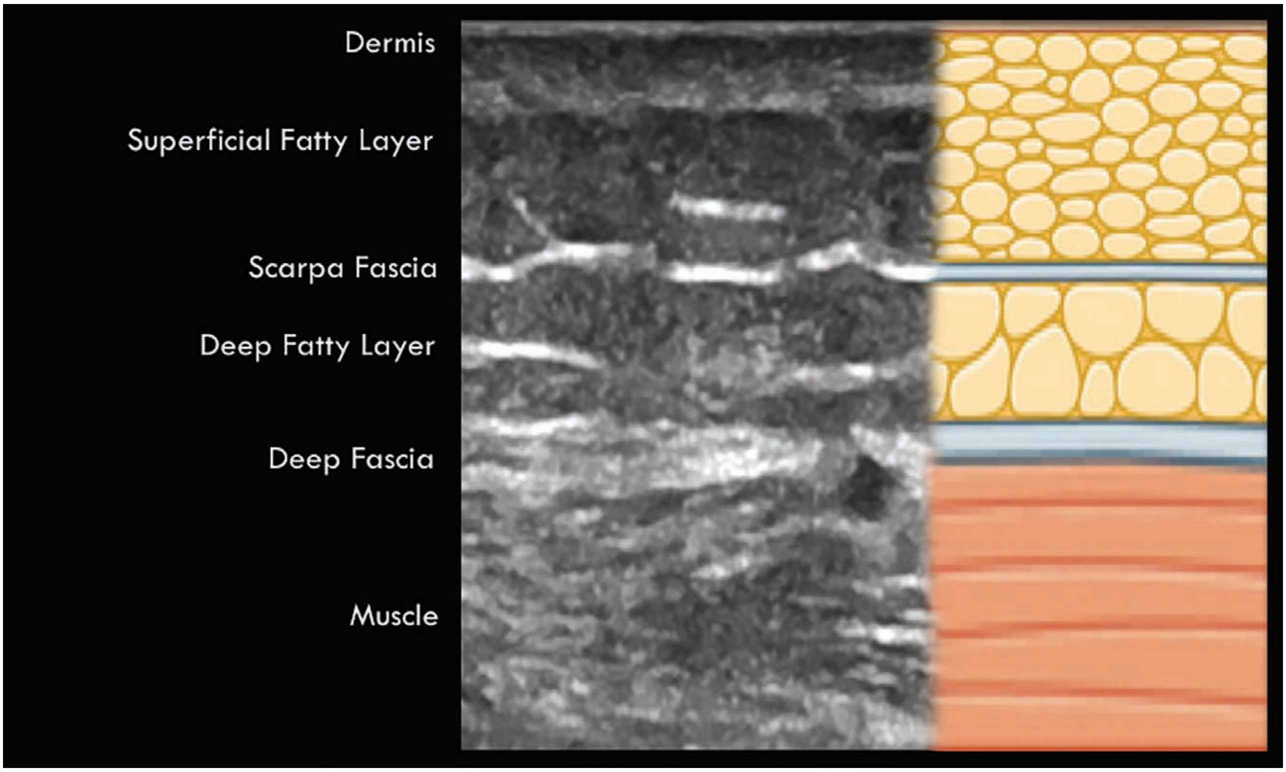

Fig. 1. Schematic representation of an ultrasound image showing the fatty layers on the desired measure point of the TAP flap.

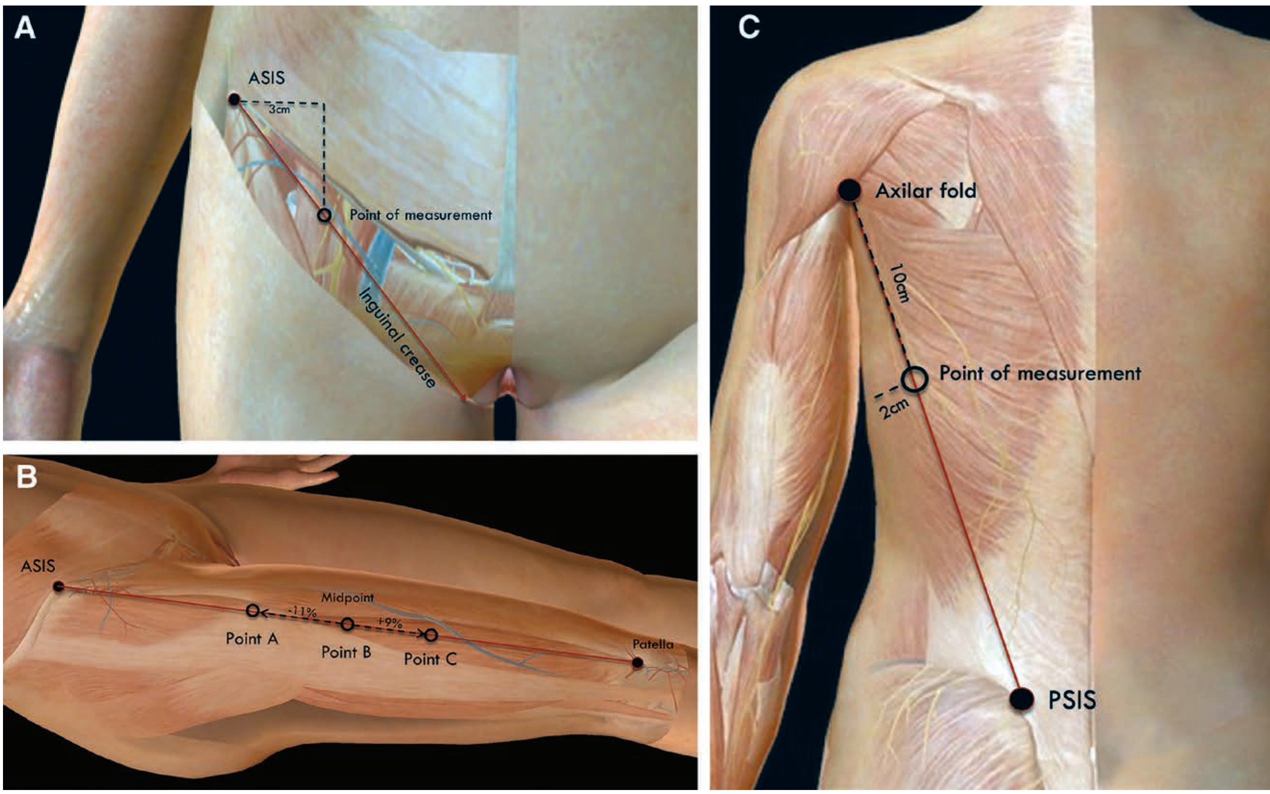

Fig. 2. Schematic representation showing the point of measurement for the different flap donor areas. A, SCIP; B, ALT; and C, TAP.

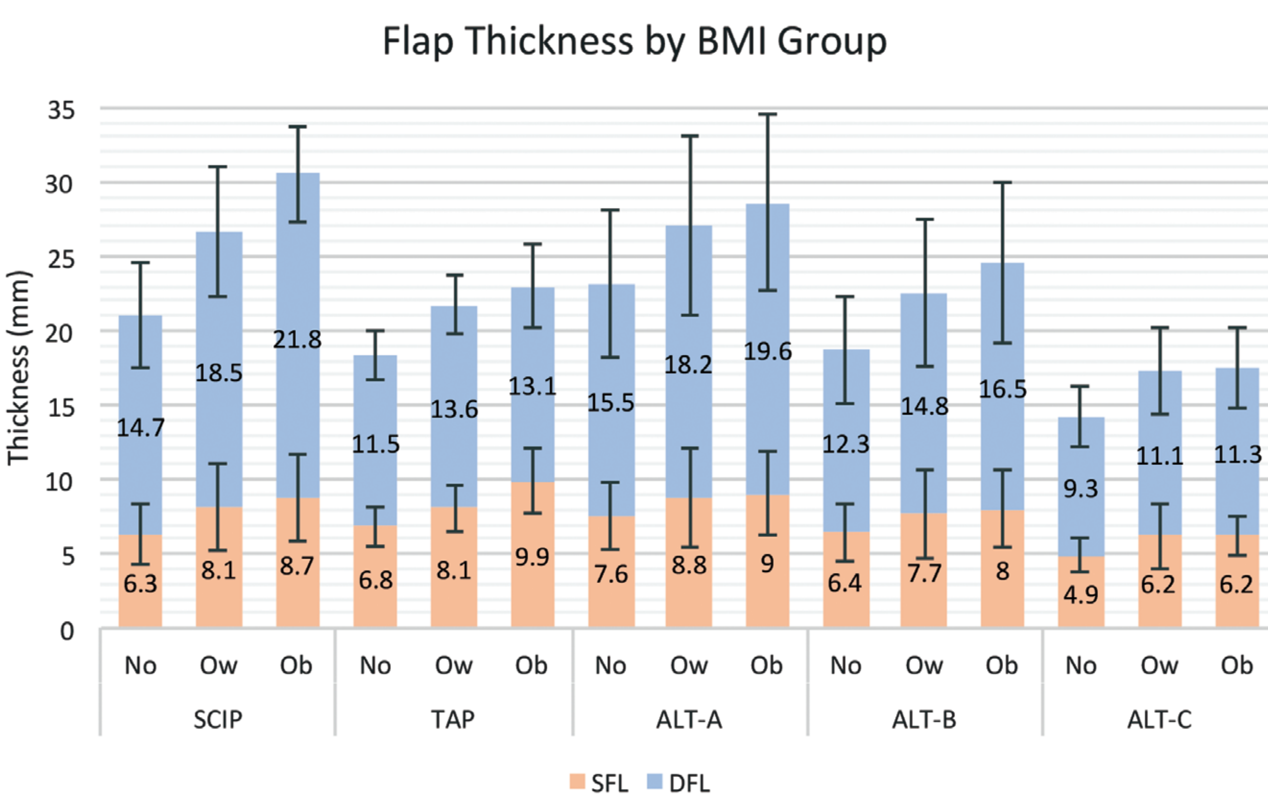

Fig. 3. The schematization of the fat's thickness and distribution between the SFL and DFL among all the flaps measured, compared between the different BMI groups. No, Normal weight; Ow, Overweight; Ob, Obese.

Table 1. The Measured Thickness of the 122 Studied Flaps with Their SD

Flap	SFL (mm)	SD	DFL (mm)	SD
SCIP	7.3	±2.7	17.15	±4.7
ALT-A	8.1	±2.8	17.1	±5.6
ALT-B	7.1	±2.6	13.8	±4.7
ALT-C	5.6	±1.7	10.2	±2.7
TAP	7.8	±2.0	13.11	±2.8

Table 2. The Simple Linear Regression Equations with Their Statistical Significance

Flap	Men	*P*	Women	*P*
SCIP$_{SFL}$	(BMI × 0.2) + 1.88	0.011	(BMI × 0.341) − 1.01	0.067
SCIP$_{DFL}$	(BMI × 0.522) + 2.99	0.030	(BMI × 0.859) − 3.91	0.025
ALT-A$_{SFL}$	(BMI × 0.255) + 0.79	0.011	(BMI × 0.193) + 3.96	0.023
ALT-A$_{DFL}$	(BMI × 0.64) − 1.97	0.001	(BMI × 0.371) + 10.14	0.012
ALT-B$_{SFL}$	(BMI × 0.217) + 0.71	0.010	(BMI × 0.207) + 2.68	0.010
ALT-B$_{DFL}$	(BMI × 0.493) − 0.83	0.001	(BMI × 0.483) + 3.38	0.027
ALT-C$_{SFL}$	(BMI × 0.184) + 0.56	0.003	(BMI × 0.174) + 1.45	0.001
ALT-C$_{DFL}$	(BMI × 0.323) + 1.38	0.001	(BMI × 0.276) + 3.73	0.005
TAP$_{SFL}$	(BMI × 0.216) + 2.30	0.036	(BMI × 0.351) − 1.14	0.047
TAP$_{DFL}$	(BMI × 0.421) + 2.49	0.018	(BMI × 0.562) − 1.26	0.043

measurements. Finally, a simple linear regression analysis was performed to predict the different flaps' thickness according to BMI. The study was carried out using SPSS Statics, version 20 for PC.

RESULTS

A total of 122 cases were used: 57 men (47%) and 65 women (53%). They were separated into 3 groups, as described by the WHO. Of those cases, 61 had normal weight (<25.0 kg/m^2), 38 were overweight (25.0–29.99 kg/m^2), and 23 were obese (>30.0 kg/m^2). No further stratification was done due to the lack of morbidly obese patients among our population. The measured thickness by flap is shown in Table 1, resulting in a simple linear regression analysis as shown in Table 2. The schematization of these results is shown in Figures 4 and 5.

- *SCIP:* When analyzing the BMI, a significant increase in thickness in the SFL was found in overweight patients (P = 0.029), compared with that in the normal-weight group. However, when comparing the overweight with obese patients, no difference was encountered among the SFL (P = 1.000), reflecting a decreased ratio of SFL-DFL, the higher the BMI measure (Fig. 6). No statistical difference in thickness was revealed among age groups (P = 0.706) neither between genders (P = 0.204 in SFL and P = 0.110 for DFL), as shown in Figure 5.
- *ALT:* Interestingly, no difference in thickness in the SFL was found between normal and overweight patients (in point A and B, P = 0.068 and P = 0.069, respectively), and between overweight and obese patients (P = 1.000, in points A, B, and C). However, a significant statistical difference was revealed in SFL between normal and

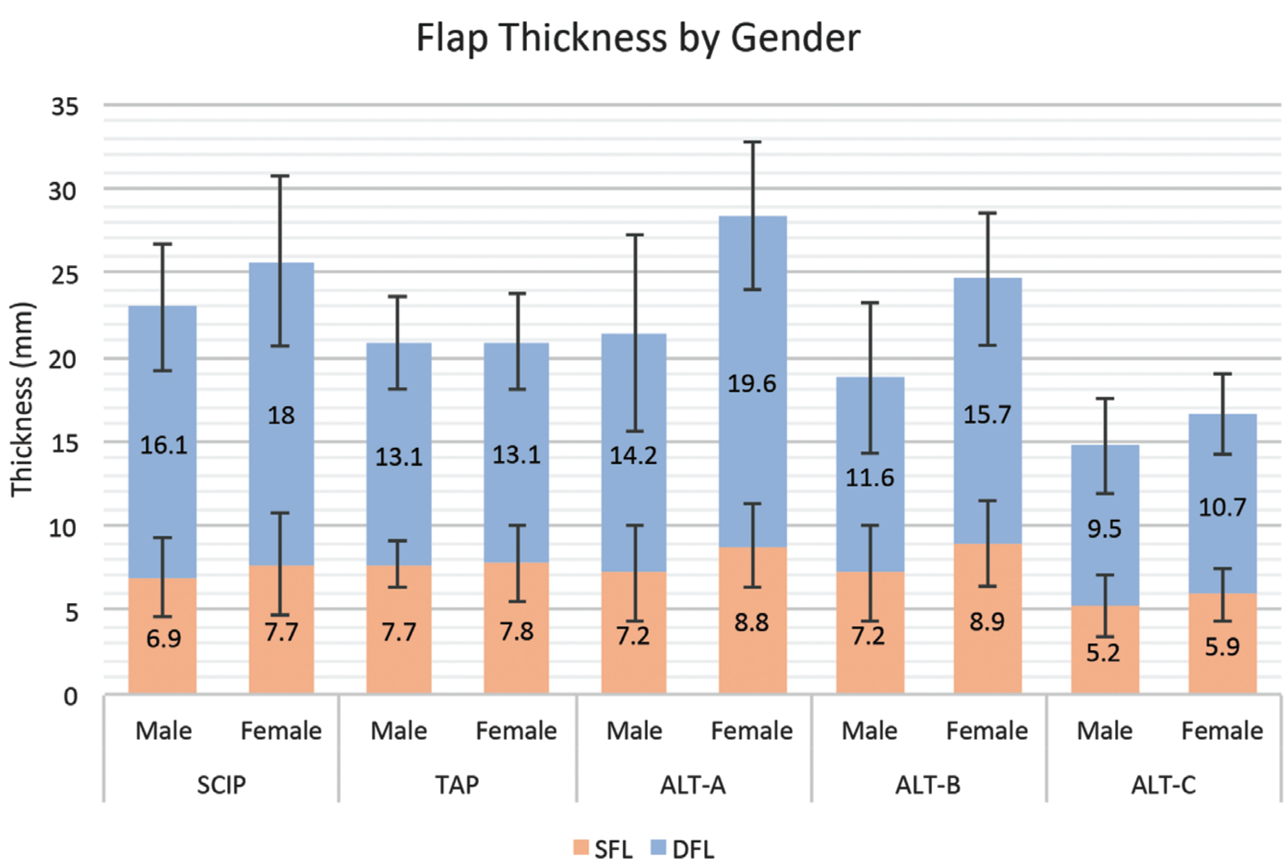

Fig. 4. The schematization of the fat's thickness and distribution between the SFL and DFL, among all the flaps measured, compared by gender.

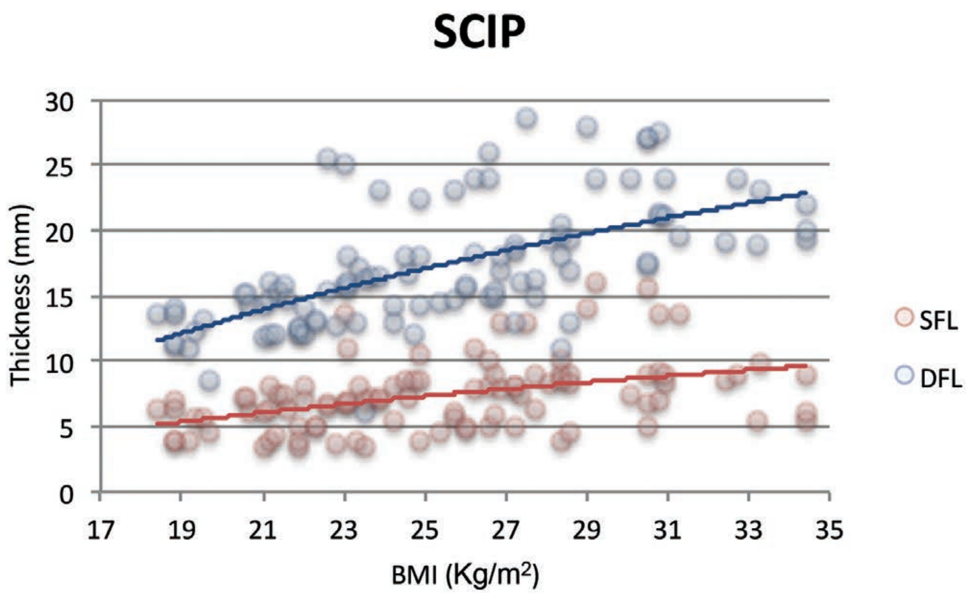

Fig. 5. The thickness distribution of the measured point in the SCIP flap for each patient was compared between the SFL and the DFL. Arranged by the different BMI measurements, and summarized by a logarithmic line.

overweight patients in point C ($P = 0.048$). Presenting a decreasing ratio of SFL-DFL accordingly, to the BMI increased. The latter, showing an increase of 0.50, 0.48, and 0.29 mm per Kg/m^2 increased in the DFL, for A, B, and C points, respectively. Nevertheless, no statistical difference of thickness between different age groups in the 3 different points measured could be revealed ($P = 0.324$). When compared between genders, a higher thickness was revealed among women (Fig. 6). Women presented a significantly higher thickness in both SFL and DFL (at point A, B, and C), in comparison with men ($P = <0.001$), as shown in Figure 5.

- *TAP*: An increase of 0.21 and 0.42 mm for each kg/m^2 for the SFL and the DFL, respectively, was encountered (Fig. 7). However, no significant differences were observed between the SFL and DFL ratio among the different BMI measures ($P = 0.819$). Nevertheless, a slight decrease in thickness in the SFL was registered among patients aged 50 years or more (7.3 versus 8.0 mm), though no statistical difference was indicated ($P = 0.390$). When genders were compared, no significant statistical difference was found, either in SFL ($P = 0.854$) or in DFL ($P = 0.779$), as shown in Figure 5.

DISCUSSION

The final goal of reconstruction surgery is to achieve the most outstanding functional and esthetic outcome in a single stage. Therefore, multiple studies have been conducted, aiming to measure subcutaneous thickness for the ideal flap selection.[10–14] None of these had studied the SFL and the DFL in microsurgery independently. Although previous studies have been published measuring the superficial and DFL of abdominal and gluteal fat, they were not aimed for liposuction and lipoinjection.[15,16]

Today, obesity is considered a relative contraindication for free flap surgery because it has been linked to higher complication rates, such as venous thromboembolism, infection, and total flap loss, among others.[17,18] The latter is caused by decreased myofibroblast activity and deranged collagen maturation.[19] However, in recent studies, it has been reported that in the head-and-neck and lower-extremity free-flap surgery, medical complications are equally found for those with a higher BMI.[20,21] The same as in breast reconstruction, it has been proved to be a reasonable and safe approach for women with a BMI of <35.[3] The latter suggests that the popular idea that obesity is a relative contraindication for free flap surgery should be abandoned.

It is expected that the higher the BMI measurement, the thicker the subcutaneous tissue would be, making most of the traditional flaps bulky in the obese patients, yielding poor results. Subfascial flaps are more likely to need secondary surgeries for debulking. Thus, intending to reduce this, multiple flaps have been described with a superficial fascial dissection plane. Among these, the ALT, SCIP, and TAP flaps are our subjects of study.[9,22,23] Today, superficial fascial flaps have been extensively used in microsurgery, primarily when encountering defects with lesser depth, demanding a pleasing contour, like head and neck reconstruction.[23–26]

In this study, we found that contrary to the torso, the SFL remained within a similar thickness between overweight and obese patients in the lower extremity. This observation could be of crucial importance for choosing a flap for covering a small-depth defect.

The average flap measurement presented here was within the range of that of previous clinical studies.[6,8,9,27] Due to the ALT flap versatility, it has been considered the workhorse flap. Moreover, with the superficial fascia

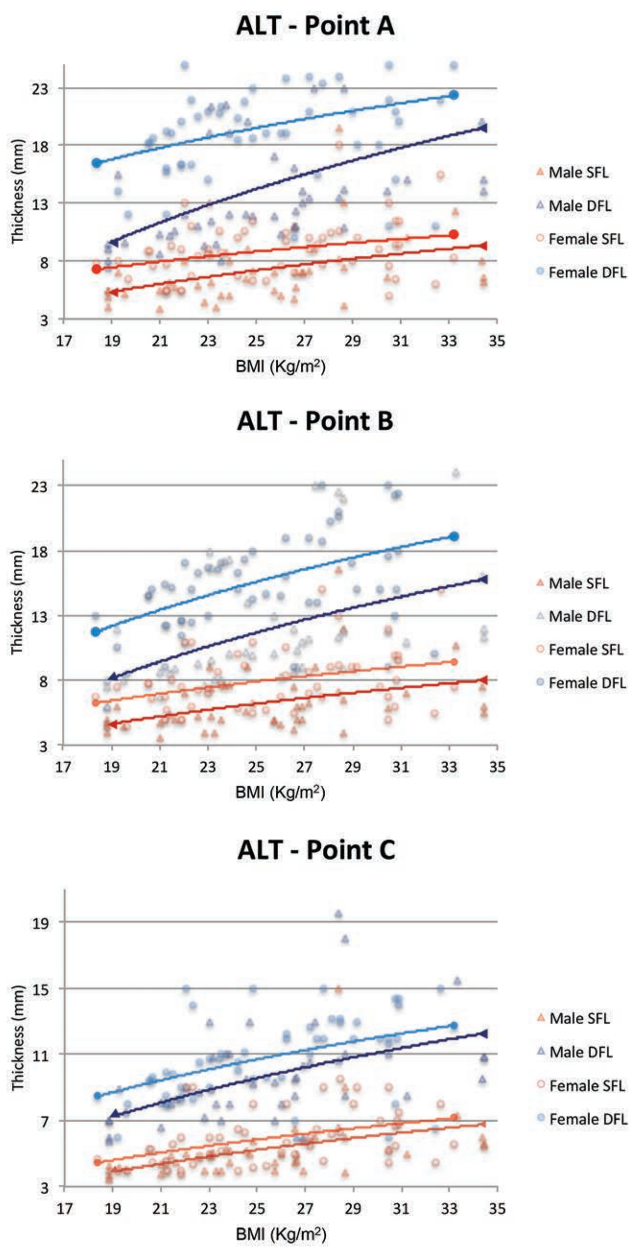

Fig. 6. The thickness distribution per point measured (A, B, and C) in the ALT fllap for each patient was compared between the SFL and the DFL. Arranged by the different BMI measurements, and summarized by a logarithmic line. A, Representation of point A; B, representation of point B; C, representation of point C.

dissection, some of the donor site complications can be reduced.[24] In a previous study, the ALT flap measurement was at the proximal fourth, middle, and distal points along the line between the anterior superior iliac spine and the patella's superior lateral border.[10] Measurements considered with a low clinical application since most common perforators are at the midpoint (±6 cm). Therefore, it was decided here to measure at the point of most common perforator localizations.[8] The ratio of SFL and DFL found in this flap was lower in the proximal region. The SFL represents 47% of the subcutaneous thickness for point A, and 51% and 54% for points B and C, respectively. The gender analysis showed that women tend to have thicker subcutaneous fat than men, as previously reported.[10] Interestingly, we found that the increase of 1 kg/m^2 (BMI) was more strongly related in men to a higher thickness than in women, especially in point A and C, somewhat similar to previous studies.[13]

The SCIP flap initially found a considerable thickness until the description of the superficial fascial dissection 15 years ago has proved great utility. It has the advantage of a concealed scar, providing a moderate amount of thin skin, which usually has a good color-matching with the face, and in most cases, with scarce hair.[23] In the present work, this flap proved to be consistent between men and women, with no difference between ages. In addition, most importantly, the SFL revealed no major difference between different BMI groups.

The superficial fascia is easily distinguished in the torso, making the dissection accessible in this area, obtaining a large but thin TAP flap,[28] making it one of the ideal flaps for reconstruction of large superficial defects.[29] In our study, we found that SFL accounts for 59% of the whole subcutaneous thickness, making it the one with the highest ratio in the study, compared with 50% in the ALT and 42% with the SCIP. Furthermore, this ratio does not seem to change significantly among age, gender, and BMI.

It is known that age tends to reduce the thickness of the SFL in the abdominal and gluteal regions.[15,16] This may be explained by the lipodystrophic nature of subcutaneous fat and its low capacity to act as lipid storage sites in older persons. The latter could result in low uptake and buffer the circulating free fatty acids, which might trigger several diseases.[30] However, we could not find a statistical significance in this matter, which might be because we ruled out almost all comorbidities, demonstrating only a minor tendency in the TAP region.

CONCLUSIONS

The SFL thickness in the lower extremity (SCIP and ALT) was somewhat similar in thickness between the different BMI groups, breaking the paradigm that flaps in an obese patient would be bulky and would need future defatting procedures. Here, a potential area was revealed when choosing the superficial facia dissection plane to elevate flaps for the hand, foot, head, and neck defects amid obese patients. Thus, a better understanding of flap structure and physiology in obese patients will lower complications, giving more predictable results. Therefore, further studies should be conducted regarding the vascular anatomy and physiology in these patients.

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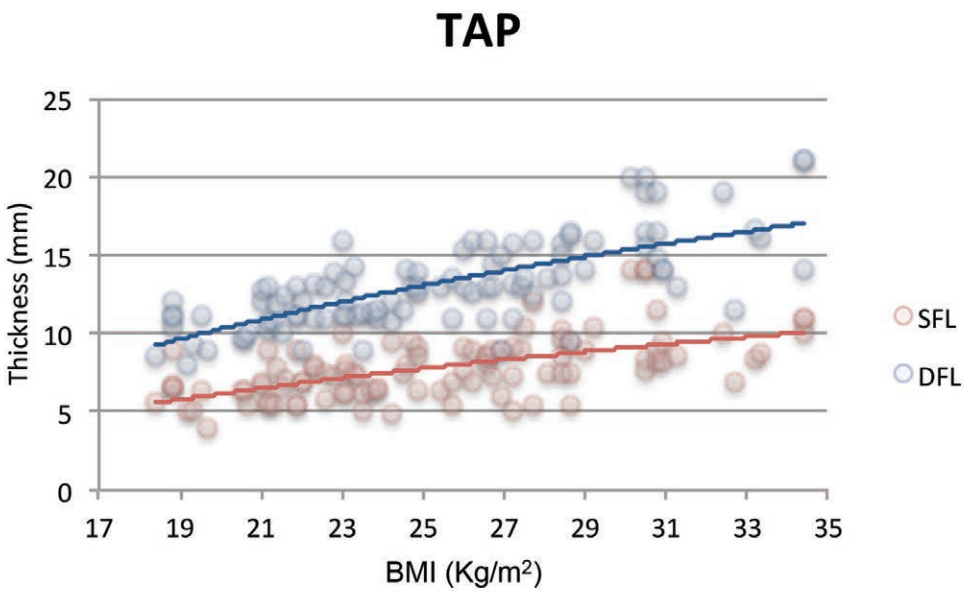

Fig. 7. The thickness distribution of the measured point in the TAP flap for each patient was compared between the SFL and the DFL. Arranged by the different BMI measurements, and summarized by a logarithmic line.

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