Review Article

Fibrosis Management Algorithm in Secondary Liposculpture

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Abstract

Background: Liposuction is considered one of the most common procedures in plastic surgery. However, major postoperative complications such as visceral injury, fluid overload, and necrotizing fasciitis still occur. Likewise, minor complications such as ecchymosis, seromas, infections, and contour irregularities that do not threaten the life of the patient do generate significant dissatisfaction. Current evidence regarding the management of fibrosis after previous liposuction remains limited.

Objectives: The objective of this article is to standardize a management algorithm based on the extensive experience and successful results of the primary author (G.M.).

Methods: Patients who underwent secondary liposculpture between August 2022 and May 2023 were evaluated prospectively. Inclusion criteria comprised females between 18 and 60 years old, nonsmokers, with a BMI < 35 kg/m^2 and a history of previous body contouring surgeries. Identification of the patient's skin condition and subcutaneous lesions in the adipose tissue were obtained in detail. Statistical analysis of preoperative and postoperative medical photographs was also performed with the Fiji Biological image analyzer.

Results: Photographic analysis of preoperative and postoperative photographs showed a statistically significant difference between the areas affected by fibrosis ($P < .001$). The most frequent clinical findings were depressions in 99% of the females (74), followed by soft nodules in 95% (70), hard nodules in 81% (61), adhesions in 47% (35), and finally cutaneous bursas in 4%.

Conclusions: Our classification system and management algorithm for fibrosis and contour irregularities is a safe and reliable tool. Results were objectively verified, yielding statistically significant outcomes.

Level of Evidence: 3

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Liposuction is a procedure that aims to improve body contour by removing adipose tissue from the subcutaneous space in different proportions, depending on the area to be handled.[1] Over the years, liposuction has become a safe and effective surgical procedure to improve body contour, with low rates of complications and morbidity. Currently it is considered one of the most popular cosmetic

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surgical procedures worldwide and is the most common aesthetic procedure in the United States and among 35- to 64-year-olds.[2-4] A total of 405,328 liposuctions were performed in 2022 in United States, with an increase of 124% between 1997 and 2015.[1,3] In Colombia, in 2021, liposuction was the most frequently performed cosmetic procedure.[5]

Secondary liposuction demand has been increasing for several years now, not only because of high rates of weight gain in the population, but also because of a high prevalence of patient dissatisfaction due to fibrosis causing irregularities in body contour.[6] Contour irregularities can be associated with improper surgical techniques, surgeons with limited experience or young surgeons, or unsuitable non-surgeon practitioners performing this procedure due to the high demand, as described by Ashton et al.[7-9] In 2007, Ericsson and colleagues suggested that to acquire expertise in a surgical technique and, in turn, reduce complications, approximately 10 years or 10,000 hours of practice are required.[10] Therefore, the rate of patients with contour irregularities has increased exponentially, and the literature has not yet established a specific classification of this condition or comprehensive management to address the alterations with which these patients present. We describe a classification based on a detailed description of physical examination findings and establish a management algorithm that includes ultrasound-assisted liposuction as the cornerstone of treatment.

METHODS

Patients who underwent secondary liposculpture between August 2022 and May 2023 in the clinical practice of the main author in Bogotá, Colombia, were evaluated prospectively. Inclusion criteria comprised females between 18 and 60 years, nonsmokers, a body mass index (BMI) < 35 kg/m^2, and a positive history of previous body contouring surgeries. Patients with an incomplete medical history, without presurgical paraclinical testing, and with significant comorbidities such as diabetes mellitus, arterial hypertension, coagulopathies, autoimmune diseases, biopolymer-induced disease, and respiratory diseases were excluded to eliminate confounding factors.

The plastic surgeon was located 60 cm from the patient during the physical examination in a room with medical-grade lighting. Identification of the patient's skin condition and subcutaneous lesions in the adipose tissue was performed in detail. Observation was performed at rest and following hyperextension movements. Subsequently, palpation by quadrants was performed to identify the different dermal lesions and their distribution. Preoperative and postoperative photographs were taken during days 1 and 10 after surgery, and during 1-, 3- and 6-month follow-up postoperative appointments to evaluate outcomes. Finally, patients were asked to rate their improvement and satisfaction from 0% to 100% during the evaluation.

Table 1. Classification of the Severity of Fibrosis in Secondary Liposculpture

Grade	Characteristic
Grade I	Depressions
Grade II[a]	Nodules
	IIa: Soft nodules
	IIb: Hard nodules
Grade III[b]	Adhesions
Grade IV[c]	Cutaneous bursas

[a]The patient may or may not have depressions. [b]May or may not have depressions and nodules. [c]May or may not have depressions, nodules, and adhesions.

Features Guiding Surgical Approach

Because most authors describe contour irregularities as a unique entity, the main author developed a personal classification based on the patient's subdermal anatomic behavior and his vast experience managing patients undergoing nonprimary liposculpture procedures.[11-13] The following straightforward terms were employed to cluster patients with particular phenotypic features that would guide the surgeon toward a specific surgical approach:

- Depressions: Areas generated by excessive suction that do not contribute to the body contour, are not symmetrical, and affect the aesthetic result.
- Soft nodules: Rounded and palpable lesions in the deep and superficial planes of the adipose tissue. They contain encapsulated fat cells and are deformed with applied pressure.
- Hard nodules: Rounded, solid, palpable lesions found in deep and superficial adipose tissue. They contain fibrin and serous fluid (pseudobursas). They are not deformable or mobile when pressure is applied.
- Adhesion: Bands of scar tissue that fuse superficial and deep fascia.
- Cutaneous bursa: Connective tissue capsule containing serosanguinous or serous fluid that the body is unable to reabsorb.

As the severity of fibrosis increases, more irregularities in the body contour become evident during physical examination, with the presence of bursas indicating severe fibrosis with the highest level of complexity. We established 4 degrees of fibrosis severity (from less to more complex)

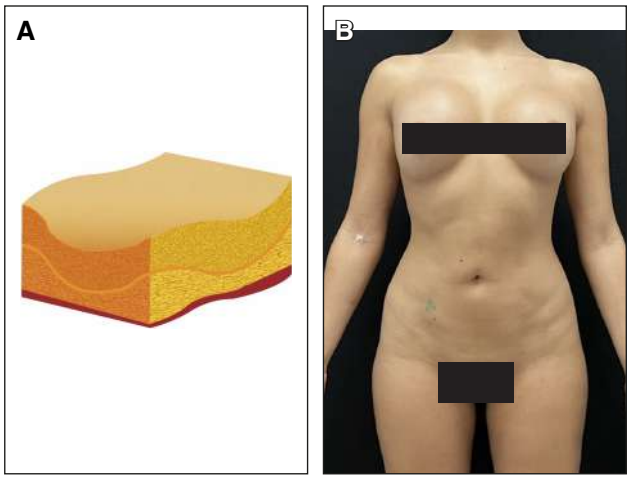

Figure 1. (A) Cutaneous depressions generating asymmetries. (B) A 30-year-old female patient with 4 previous liposuctions and abdominal depresssions.

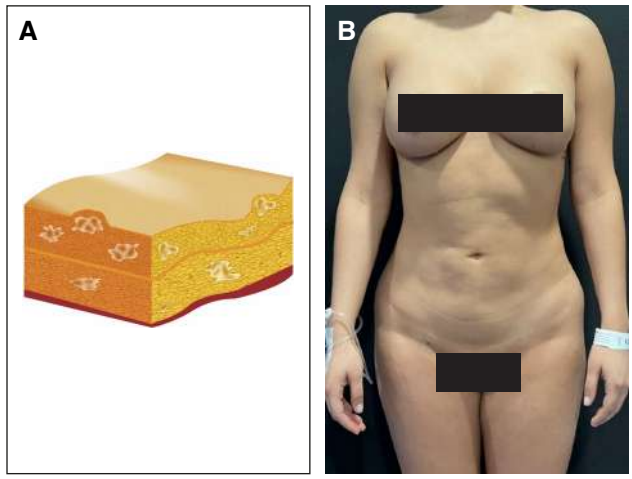

Figure 2. (A) Soft nodules with fat cells encapsulated by scar tissue that are deformable when applying pressure. (B) A 27-year-old female patient with 2 previous liposuctions and soft nodules over the abdominal wall.

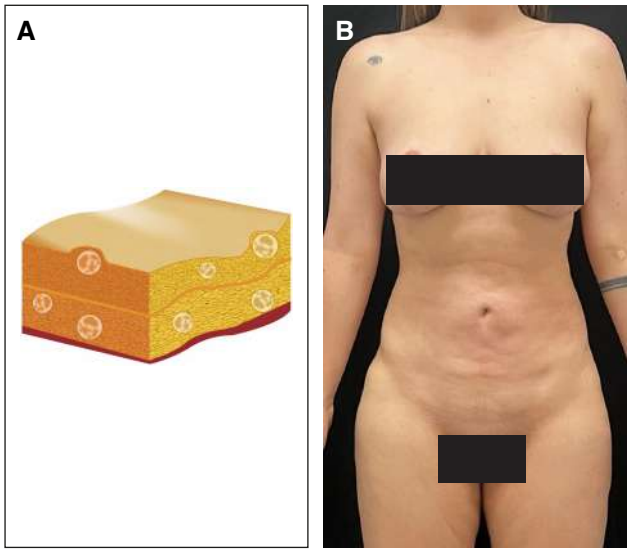

Figure 3. (A) Hard nodules with abundant fibrin tissue, not deformable when applying pressure. (B) A 37-year-old female patient with 2 previous liposuctions and hard nodules over the abdominal wall.

depending on which of the aforementioned clinical findings were present (Table 1 and Figures 1-5).

To objectively evaluate the postoperative outcomes, we asked an expert surgeon to analyze and compare the preoperative vs postoperative photographs with a validated program (Fiji; ImageJ, Bethesda, MD).[14] This surgeon was not involved in the patient's preoperative evaluation and did not participate in the procedure, and it was considered a blinded evaluation. We carried out 5 different measurements based on the surgeon's judgment about the areas where fibrosis was present. Mean and standard deviation calculations were made, and a repeated-measures *t* test was administered for statistical analysis.

Additionally, intraoperative ultrasound scans were conducted on 15 patients before the implementation of technological interventions. The aim was to objectively identify irregularities, spanning both the superficial and deep fat layers. Upon conclusion of the procedure, a repeated ultrasound assessment was performed at the identical site to evaluate changes in adipose layers.

Management Algorithm

We described a specific algorithm for patient management based on patient classification after physical examination findings (Figure 6).

Grading System

Grade I: Depressions

Tissue liberation was performed with VASER (Solta Medical, Bothell, WA) at 40% in continuous mode around depression zones to homogenize the tissue. In the surrounding areas, VASER at 60% was employed in continuous mode to emulsify the fat. Fat grafts were placed when needed to improve contour.

Grade II: Nodules

- Grade IIa. Soft nodules were treated with VASER from 60% to 70% in continuous mode inside the nodule. In the surrounding tissues we utilized intermittent mode to break the fibrotic bands.

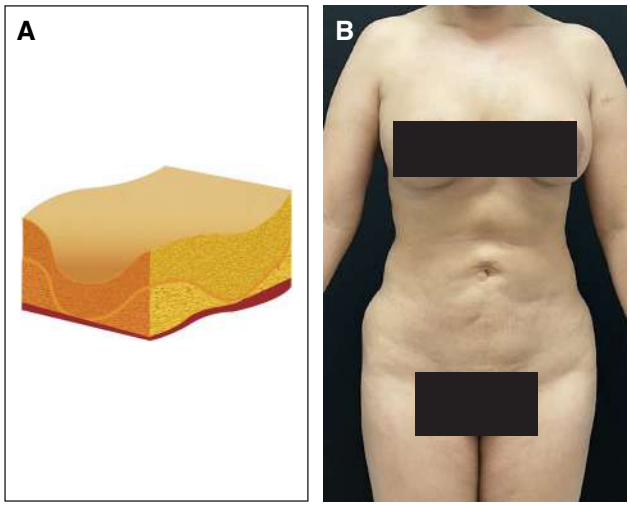

Figure 4. (A) Adhesions between the superficial and deep fascia. (B) A 36-year-old female patient with 2 previous liposuctions and adhesions in fat layers.

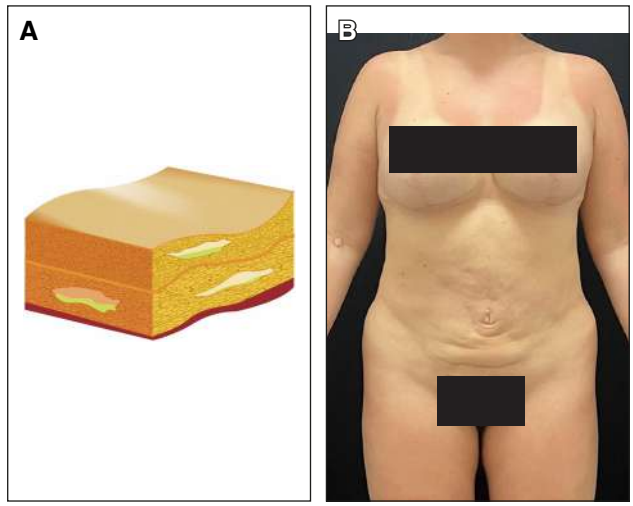

Figure 5. (A) Bursas or connective tissue capsules that store serosanguinous or serous fluid. (B) A 28-year-old female patient with 1 previous liposuction. She has an infraumbilical bursa.

- Grade IIb. Hard nodules were treated with VASER at 40% in continuous mode inside the nodule as well as on its periphery.
- **Grade III: Adhesions Grade**

  First, the adhesions were torn with an 18G needle, making cuts perpendicular to the tissue fibers. Then, fat grafts were homogeneously injected in the treated area with a 2-mm blunt-tipped cannula and 3-cm syringes.
- **Grade IV: Cutaneous bursas**

  Typically, these bursas were located on the abdominal wall. With a mini-lipectomy approach, the bursa was located, and a complete resection was carried out if feasible. Baroudi-type sutures were placed to reduce dead space. If any bursa remained, a bursotomy was performed on the capsule.

Surgical Technique

Markings were performed with the patient in a standing position. The patient was positioned in a prone position on the operating table. Incisions were made over hidden areas according to patient needs. A tumescent solution was infiltrated, with 100 mg of tranexamic acid, 1 mg of epinephrine, 3 mL of 1% lidocaine without epinephrine (0.3 mg), and 1 mL (1 mEq) of sodium bicarbonate per 1000 mL of saline solution. A minimum of 10 minutes was allowed for adequate hemostasis. The procedure began with ultrasound-assisted fat emulsification at a power setting between 40% and 80% in both the deep and superficial planes with VASER. This was essential for managing fibrosis. The degree of fibrosis was identified and managed according to our aforementioned algorithm.

Once the surfaces were prepared, fat was aspirated with a MicroAire device (MicroAire Surgical Instruments, Charlottesville, VA) with a no. 4 cannula with 3 and 5 holes in the deep plane. The proper trajectory of the cannula was verified with the nondominant hand. The pinch test was performed to ensure symmetry, and a Penrose drain was placed in the sacral area for drainage and secured with a 2-0 silk stitch, which was removed after 5 days. The incisions in the upper back were closed with a simple 4-0 polypropylene suture, which was removed after 8 days. The same procedure was repeated with the patient in a supine position, and at the end of the procedure, the adequacy of abdominal wall normalization was checked. In severe cases in which there was a lack of fatty tissue with adhesions in both the deep and superficial planes, fat graft was added to correct these defects. For areas requiring lipoinjection, we recommended performing decantation, washing, and purification of the fat, carefully removing waste, fluids, and dead cells. The filtered fat was then transferred into two 50-mm syringes and connected with a Luer-Lock connecting tube (Surgest Medical, Barcelona, Spain), which was moved back and forth multiple times until the fat reached a liquid state. For the extraction of stem cells, we utilized the technique of Carlos Guerrero, an orthopedist specializing in stem cells (see Appendix, available at www.aestheticsurgeryjournal.com). The incisions made beneath the breast area were closed with polypropylene suture, and the rest remained open for free drainage. Videos 1-6 demonstrate the techniques utilized in this study.

Postoperative Management

The postoperative management had certain variations from the conventional approach in primary liposuction.

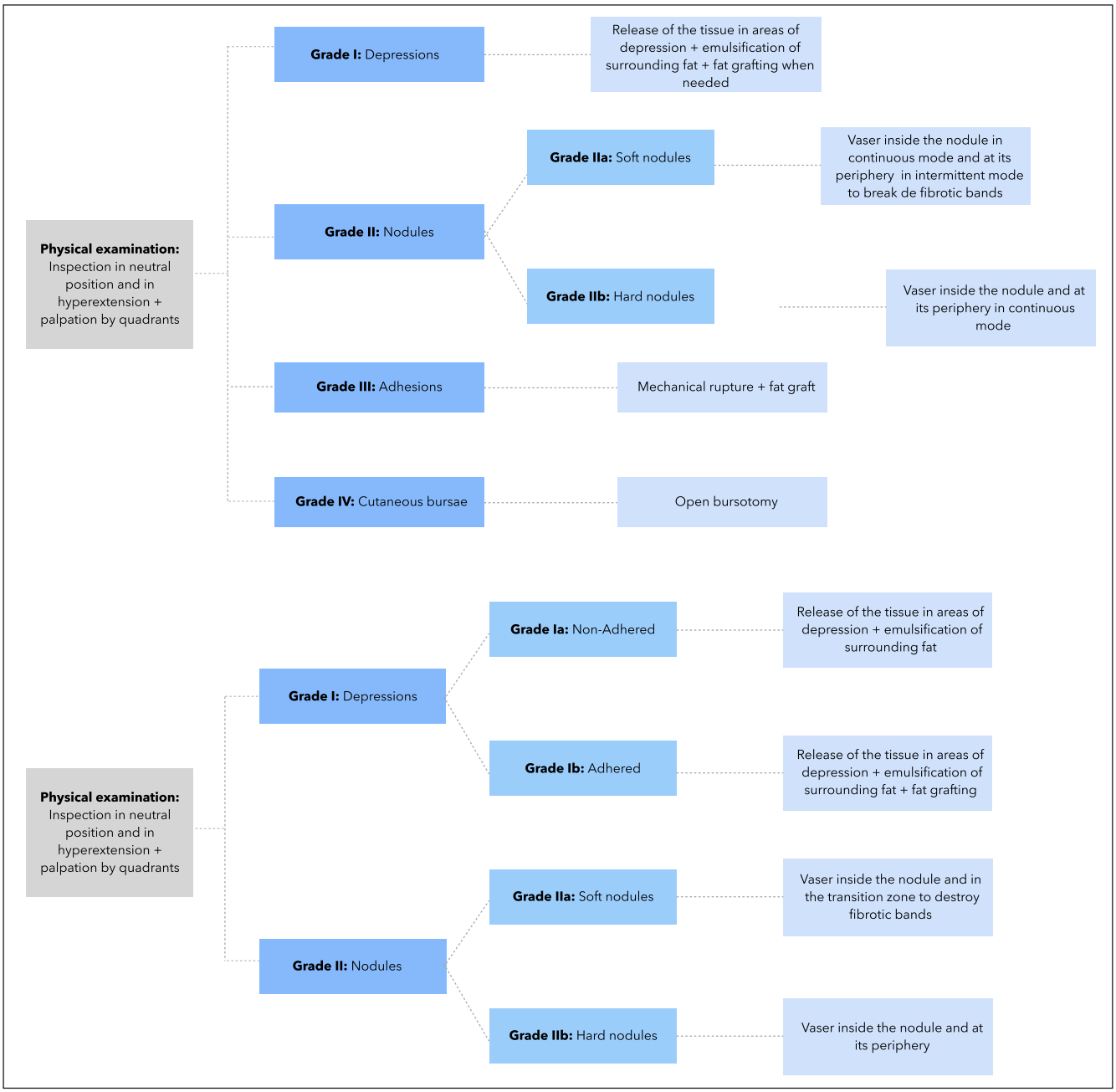

Figure 6. Fibrosis management algorithm in secondary liposculpture.

However, some fundamental principles remained intact. It was imperative to initiate a low compression garment immediately following the surgery, which was left in place for 3 days, in conjunction with foam and a board. Transitioning to a high compression garment began on the fourth day. Adjustments regarding compression may be dependent upon the individual patient's progress.

Lymphatic drainage therapy began on the first day and should be done daily, with a minimum of 10 sessions recommended. There was a possible need for additional lymphatic drainage sessions; however, the exact number depended upon the patient's recovery.

In addition, supplementary technologies such as ultrasound, carboxytherapy, radiofrequency, and cryotherapy were employed in accordance with the specific requirements of each case. It is noteworthy that in cases involving the placement of stem cells and lipografts on the

Video 1. Watch now at http://academic.oup.com/asj/articlelookup/doi/10.1093/asj/sjae026

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abdominal wall, massages began on the sixth day following the surgery.

Regarding secondary liposuction, it is of greatest importance to clarify to the patient that the final outcome may not become apparent until approximately 1 year postoperatively. During this period of time, fluctuations in the recovery process should be anticipated.

Ethical Considerations

The present research had a minimal risk according to the guidelines for health research established in Colombian resolution 8430 of 1993, and the research adhered to the Declaration of Helsinki, respecting the integrity and confidentiality of individuals included.[15] All patients signed

Table 2. General Characteristics of the Population

Variable	(*n* = 75)
Sociodemographics	
Sex	
Female	75 (100%)
Male	0 (0%)
Age (years)	36 (31.5-42)
BMI (kg/m^2)	24.51 (2.5)
Number of previous surgeries	1.64 (0.83)
Clinical findings	
Depressions	74 (99%)
Soft nodules	70 (93%)
Hard nodules	61 (81%)
Adhesions	35 (47%)
Cutaneous bursas	3 (4%)
Surgical technique	
Use of VASER ultrasound	75 (100%)
Use of MicroAire	75 (100%)
Use of fat grafts	17 (23%)
Liposuction volume (mL)	2768 (847.28)
Tumescent solution infiltration volume (mL)	5958.67 (2211.28)
Patient satisfaction evaluation (%)	
1-day follow-up	77.73 (9.81)
10-day follow-up	81.60 (7.36)
1-month follow-up	84.66 (7.65)

Variables were summarized as mean and standard deviation or median and interquartile range depending on the observed distribution (Shapiro-Wilk $P < .05$). BMI, body mass index.

informed consent authorizing the use of their data and photographs for research purposes.

RESULTS

A total of 75 female patients with an average age of 37.3 years (range 19-60 years) who presented with fibrosis secondary to previous liposuctions and underwent revisional surgery between August 2022 and May 2023 were analyzed. The general characteristics are summarized in Table 2. A significant improvement in body contour irregularities and general appearance was achieved in all patients. The most frequent clinical findings were depressions, in 99% of the females (74), followed by soft nodules in 95% (70), hard nodules in 81% (61), adhesions in 47% (35), and finally cutaneous bursas in 4% (3).

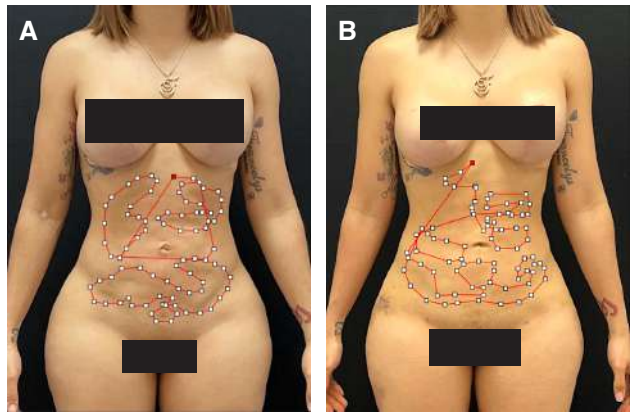

Figure 7. A 29-year-old female patient with a BMI of 22.9 kg/m^2 who has undergone 2 previous liposuctions and has grade III fibrosis. A total of 4900 mL was infiltrated, and 3000 mL was liposuctioned, with an abdominal fat graft placed. We utilized the Fiji Biological image analyzer to compare (A) the preoperative area with fibrosis and/or asymmetries with (B) the 1-year postoperative area.

All patients underwent VASER and power-assisted liposuction with a mean tumescent solution infiltration volume of 5958.67 mL (2211.28). The average volume extracted was 2768 mL (847.28). Fat grafts were placed to homogenize the abdominal wall in almost a quarter of the patients. Follow-up was performed daily during the first 10 postoperative days and once a month afterward. No major or minor complications were observed. Most of the patients displayed an initial BMI in the overweight range, and subsequent to the surgical procedure a decrease of approximately 3 to 5 BMI points was recorded, resulting in an average weight loss of 8 kg. All patients perceived an improvement and were satisfied with the postoperative results.

Photographic analysis showed a statistically significant difference between the preoperative and postoperative photographs of the areas affected by fibrosis ($P < .001$). Confidence intervals were specific for each measurement (see Supplemental Figures 1-6, Supplemental Tables 1-8, available at www.aestheticsurgeryjournal.com, and Figure 7).

The ultrasound images obtained before and after the surgical procedure, following the algorithm, confirmed improvement in the organization and normalization of adipose tissue, with the removal of soft and hard nodules (Figure 8A-D).

Complications

During postoperative follow-up of the patients in this study, minor complications were documented, including seromas

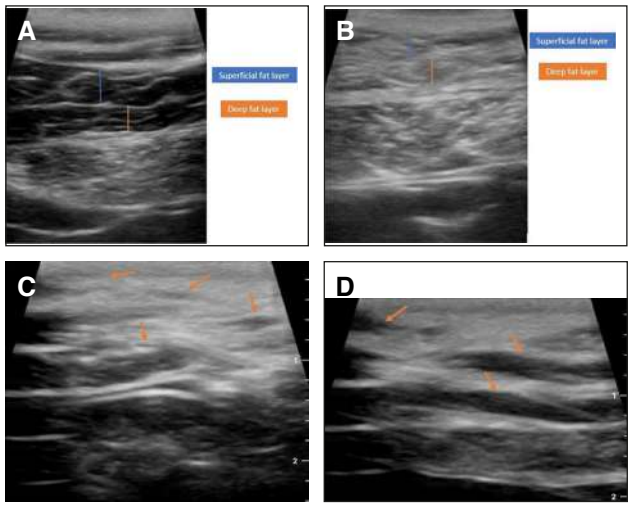

Figure 8. Ultrasound image of a 43-year-old female patient with 2 previous liposuctions. Images before surgery and upon completion in the abdominal area. (A) Irregularities in superficial and deep fat layers preatreatment. (B) Homogenization and regularization across distinct layers of adipose tissue posttreatment. (C) Soft nodules in superficial and deep fat layer pretreatment. (D) Hard nodules in superficial and deep layer pretreatment.

in 2 patients (1.5%) and 1 hematoma (0.75%), which did not require intervention; all of these resolved without any lasting consequences. There were no major complications reported.

DISCUSSION

Despite the significant advances in liposuction, certain complications frequently occur, including seromas, bruises, infections, overcorrection, skin laxity, hyperpigmentation, skin necrosis, and contour irregularities, among others.[16,17] Incidence of contour irregularities and asymmetries has been reported to vary from 1.7% to 14.9%, according to different authors, depending on diverse factors, such as the technologies utilized.[16,18-20] What is certain is that contour irregularities are more commonly seen in the practices of plastic surgeons. To date, procedures such as liposuction in lipodystrophy zones, fat grafts, and lipectomy have been proposed as plausible solutions.[21,22]

However, a specific protocol for treatment has not yet been established, nor have the abnormalities found in the tissues been described meticulously. In 2001, Fodor published a classification for secondary liposuction findings, which divided them into 4 categories: residual lipodystrophy with asymmetries, irregularities, skin redundancy, and overresection. He proposed performing corrective liposuction with or without fat graft injection to improve the body contour.[6] Pereira et al proposed 3 different treatment plans for abdominal irregularities, according to the flaccidity of the skin and visible deformities, implementing

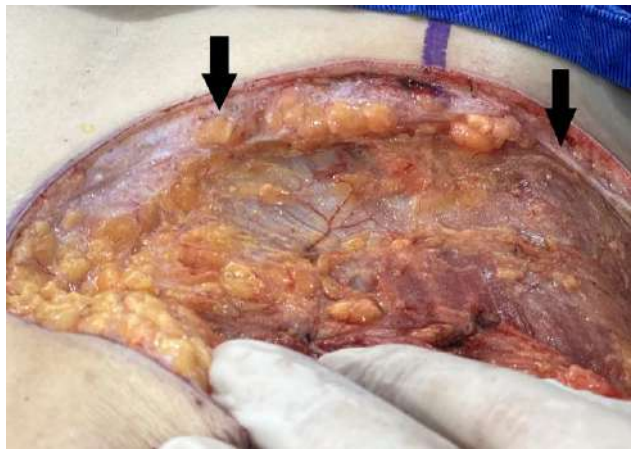

Figure 9. A 47-year-old female patient with a history of liposuction and mastopexy underwent scar revision of the mammary fold, where irregularities were observed in adipose layers due to her previous liposuction. The arrows in the thoracoabdominal area indicate a hard nodule (left) and fusion of fascia (right), also known as adhesion.

fat transfer, mini-lipectomy, or abdominoplasty without technology, depending on the specific findings.[21]

The main author has successfully applied our algorithm for the management of post-liposuction fibrosis in more than 1500 patients, achieving resolution of irregularities in more than 90%. Our classification identifies specific problems, such as soft and hard nodules, adhesions, depressions, and cutaneous bursas. In effect, our algorithm addresses specific contour irregularities by employing technology such as ultrasound and power-assisted liposuction. This allows straightforward management of the cause of the particular irregularities, achieving an individualized treatment that leads to more predictable and reliable results. Additionally, applying technology such as VASER ultrasound during liposuction allows fat emulsification when programmed on more than 60% power, which is especially effective for soft nodules and surrounding fatty tissue. We recommend ultrasound power for emulsification at between 60% and 80%. In contrast, better energy dispersion is observed with lower powers, which is helpful in the homogenization of hard nodules and depressions, and especially in cases of severe fibrosis, in which there is limited adipose tissue that should not be emulsified or suctioned, because this would worsen the irregularities.[23] We recommend ultrasound power between 40% and 60% for energy dispersion, reorganization of fatty tissue, and homogenization. In the primary author (G.M.)'s experience, a power greater than 80% risks thermal skin injuries caused by ultrasonic vibrations and repetitive movements. Upon accurately identifying the specific irregularities and adhering to the prescribed algorithm, a significant improvement in contour was achieved in all patients. This amelioration was not only subjectively ascertained but also

objectively validated through a comprehensive analysis of photographs. The statistical significance ($P < .001$) of the results was established across all patients, evident in the comparative evaluation of preoperative and postoperative images.

The ultrasound images captured before beginning the surgery facilitated visual identification of the fibrosis irregularities, with some of them only palpable during physical examination, such as hard and soft nodules. Postoperative ultrasound images revealed a normalization of the adipose tissue layers, with no evidence of nodules. To reorganize the irregularly arranged fascias the cannula movements should be cephalocaudal and longitudinal in direction. These alterations exhibited a harmonization and regularization of the subcutaneous tissue architecture, as illustrated in Figure 8A-D. Soft nodules and fascial adhesions were observed during correction of a mastopexy scar, confirming the findings on physical examination and ultrasonographic images (Figure 9). These dual sets of measurements collectively validated the objective efficacy of the proposed algorithm. This study included a large cohort of patients who underwent surgical intervention for fibrosis secondary to previous liposuction, providing valuable insights into the prevalence and characteristics of these complications. The significance of this study lies in addressing the limited evidence and lack of standardized protocols for managing fibrosis after liposuction. By providing a systematic approach to identifying and classifying contour irregularities, this study contributes to enhancing the understanding and treatment of these complications. A personalized treatment approach based on specific findings allows for targeted interventions, leading to more predictable and reliable outcomes for patients.

Limitations

Analysis of the patients was limited due to the lack of complete sociodemographic data and the absence of high-quality photographs in some cases. Long-term photographic follow-up was not possible for foreign patients. A database with a greater number of variables is required to extend the statistical analysis. Further studies and validation of these findings are warranted to refine and improve the management of these complications.

CONCLUSIONS

Our classification system and management algorithm for fibrosis and contour irregularities is a safe and reliable tool for addressing patients undergoing secondary liposculpture. Tailored treatment strategies for each grade of fibrosis and utilization of advanced technologies effectively achieve optimal postoperative outcomes. Results were objectively verified, yielding statistically significant outcomes.

Supplemental Material

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

Disclosures

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REFERENCES

1. Wu S, Coombs DM, Gurunian R. Liposuction: concepts, safety, and techniques in body-contouring surgery. *Cleve Clin J Med*. 2020;87(6):367-375. doi: 10.3949/ccjm.87a.19097
2. Chia CT, Neinstein RM, Theodorou SJ. Evidence-based medicine: liposuction. *Plast Reconstr Surg*. 2017;139(1):267e-274e. doi: 10.1097/PRS.0000000000002859
3. The aesthetic society. Aesthetic plastic surgery national databank statistics 2022. *Aesthet Surg J*. 2023;43(Suppl 2):1-19. doi: 10.1093/asj/sjad354
4. American Society of Plastic Surgeons. Inaugural ASPS Insights and Trends Report: Cosmetic Surgery 2022. Published 2023. Accessed June 12, 2023. https://www.plasticsurgery.org/news/plastic-surgery-statistics
5. International Society of Aesthetic Plastic Surgery. ISAPS International Survey on Aesthetic/Cosmetic Procedures Performed in 2021. Published 2022. Accessed May 20, 2023. https://www.isaps.org/discover/media-centre
6. Fodor PB. Secondary lipoplasty. *Aesthetic Surg J*. 2002;22(4):337-348. doi: 10.1067/maj.2002.126754
7. Satkunasivam R, Klaassen Z, Ravi B, et al. Relation between surgeon age and postoperative outcomes: a population-based cohort study. *CMAJ*. 2020;192(15):E385-E392. doi: 10.1503/cmaj.190820
8. Beudeker N, Smits I, Spierings R, et al. Starting an autologous breast reconstruction program after plastic surgical training. Is it as good as it gets? *J Plast Reconstr Aesthetic Surg*. 2020;73(2):286-294. doi: 10.1016/j.bjps.2019.07.022
9. Ashton M, Lee M. Cosmetic surgery—why training matters. *Australas J Plast Surg*. 2022;5(2):1-4. doi: 10.34239/ajops.v5n2.413
10. Ericsson A, Prietula M, Cokely E. The making of an expert. *Harv Bus Rev*. 2006;87(May):114-121. doi: 10.1201/b17434 10.1201/b17434
11. Escandón J, Vyas K, Manrique O. High-definition lipoplasty in male patients: a systematic review of surgical techniques and outcomes. *Aesthet Surg J*. 2022;42(1):68-85. doi: 10.1093/asj/sjab300
12. Willet JW, Alvaro AI, Ibrahim AK, Javed MU. A systematic review of efficacy and complications of high-definition liposuction. *Plast Reconstr Surg*. 2023;152(1):57-63. doi: 10.1097/prs.0000000000010203

13. Danilla S, Babaitis RA, Jara RP, et al. High-definition liposculpture: what are the complications and how to manage them? *Aesthetic Plast Surg*. 2020;44(2):411-418. doi: 10.1007/s00266-019-01475-6
14. Schindelin J, Arganda-Carrera I, Frise E, et al. Fiji—an open platform for biological image analysis. *Nat Methods*. 2009;9(7):676-682. doi: 10.1038/nmeth.2019.Fiji
15. Di Ruggiero M, de los Ánegeles M. Declaration of Helsinki, bioethical principles and values involving human subjects in medical research. *Rev Colomb Bioet*. 2011;6(1):125-144. doi: 10.1007/BF00320029
16. Kanapathy M, Pacifico M, Yassin AM, Bollen E, Mosahebi A. Safety of large-volume liposuction in aesthetic surgery: a systematic review and meta-analysis. *Aesthetic Surg J*. 2021;41(9):1040-1053. doi: 10.1093/asj/sjaa338
17. Dixit V V, Wagh MS. Unfavourable outcomes of liposuction and their management. *Indian J Plast Surg*. 2013;46(2):377-392. doi: 10.4103/0970-0358.118617
18. Kim YH, Cha SM, Naidu S, Hwang WJ. Analysis of postoperative complications for superficial liposuction: a review of 2398 cases. *Plast Reconstr Surg*. 2011;127(2):863-871. doi: 10.1097/PRS.0b013e318200afbf
19. Arshad SM, Latif S, Altaf HN. A retrospective analysis of complications of large volume liposuction; local perspective from a third world country. *RMJ*. 2018;43(1):77-80.
20. Commons GW, Halperin B, Chang CC. Large-volume liposuction: a review of 631 consecutive cases over 12 years. *Plast Reconstr Surg*. 2001;108(6):1753-1763. doi: 10.1097/00006534-200111000-00051
21. Pereira LH, Sterodimas A. Treatment of iatrogenic abdominal contour irregularities. *Aesthetic Plast Surg*. 2010;34(2):129-135. doi: 10.1007/s00266-008-9233-8
22. Chang KN. Surgical correction of postliposuction contour irregularities. *Plast Reconstr Surg*. 1994;94(1):1-11. doi: 10.1097/00006534-199407000-00013
23. Massignan F. Safety evaluation of VASER® in body contouring improvement liposuction. *Surg Curr Res*. 2018;08(1):1-8. doi: 10.4172/2161-1076.1000308