Gac Méd Caracas 2024;132(1):191-202
DOI: 10.47307/GMC.2024.132.1.20

Multifrequency Laser-Assisted Lipolysis in a Patient with Excessive Redundant Skin Post Roux-en-Y Gastric Bypass: A Clinical Case and Literature Review

Lipólisis asistida por láser multifrecuencia en un paciente con piel redundante excesiva después de un bypass gástrico en y de Roux: un caso clínico y una revisión de la literatura

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SUMMARY

Patients undergoing bariatric procedures experience massive weight loss accompanied by significant soft tissue laxity throughout the body. In such cases, aesthetic surgery aims to assist in regaining body contour. However, the impact of traditional surgical procedures on redundant tissue results in extensive scars, raising concerns and dissatisfaction among patients. Multifrequency laser-assisted lipolysis is a novel modality that has proven effective in reducing residual fat and inducing skin tightening with minimal scarring. This case presents the surgical management using liposuction and multifrequency laser for the treatment of redundant skin and localized remnants of abdominal adipose tissue following Roux-en-Y gastric bypass due to a diagnosis of grade III obesity and massive weight loss secondary to this procedure with an excellent aesthetics result and prompt recovery time without surgical or medical complications.

Keywords: *Liposuction, laser-assisted lipolysis, obesity, multifrequency laser, adipose tissue.*

RESUMEN

Los pacientes sometidos a procedimientos bariátricos experimentan una pérdida masiva de peso acompañada de una laxitud significativa de los tejidos blandos en todo el cuerpo. En estos casos, la cirugía estética tiene como objetivo ayudar a recuperar el

DOI: https://doi.org/10.47307/GMC.2024.132.1.20

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Recibido: 26 de noviembre 2023
Aceptado: 5 de febrero 2024

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contorno corporal. Sin embargo, el impacto de los procedimientos quirúrgicos tradicionales en el tejido redundante produce cicatrices extensas, lo que genera preocupación e insatisfacción entre los pacientes. La lipólisis asistida por láser multifrecuencia es una modalidad novedosa que ha demostrado ser eficaz para reducir la grasa residual e inducir el estiramiento de la piel con cicatrices mínimas. Este caso presenta el manejo quirúrgico mediante liposucción y láser multifrecuencia para el tratamiento de piel redundante y restos localizados de tejido adiposo abdominal posterior a bypass gástrico en Y de Roux por diagnóstico de obesidad grado III y pérdida masiva de peso secundaria a este procedimiento con un excelente resultado estético y pronta recuperación sin complicaciones quirúrgicas ni médicas.

Palabras clave: *Liposucción, lipólisis asistida por láser, obesidad, láser multifrecuencia, tejido adiposo.*

INTRODUCTION

Obesity is a chronic, progressive, multi-factorial, and challenging-to-manage disease whose prevalence has reached pandemic proportions (1-3). The genesis of Obesity involves genetic, metabolic, psychological, and endocrinological factors interacting in different degrees and patterns in each individual, producing a unique obese phenotype known as classical polygenic Obesity (4,5).

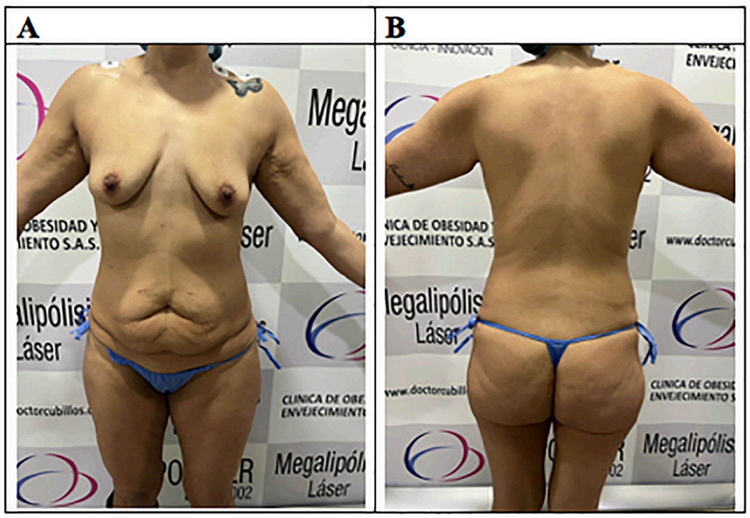
Currently, it is clear that Obesity is an independent risk factor for a wide range of related chronic diseases such as metabolic syndrome (6), type 2 diabetes mellitus (T2DM) (7), hypertension (8), dyslipidemias (9), cardiovascular diseases (CVD) (10), respiratory disorders (11), joint diseases (12), psychosocial disorders (13), and even some types of cancer including oesophagal, colon, pancreatic, prostate, and breast (14). All these diseases are likely linked to Obesity through visceral adipose tissue inflammation and, later, in subcutaneous adipose tissue, where the adipocyte becomes dysfunctional due to hypoxia, hyperglycemia, and a high-fat diet. This process leads to a pro-inflammatory adipocyte phenotype characterised by leptin hypersecretion and Interleukine-6 (IL-6), chemokine (C-C motif) ligand 2 (CCL-2), and Nuclear Factor-kB (NF-kB) overexpression, resulting in monocyte infiltration and macrophage polarisation to M2 phenotype (15).

Although achieving significant weight loss is a positive result of anti-obesity treatments, particularly in post-bariatric patients, challenges frequently emerge related to cosmetic concerns stemming from excess skin in areas such as the abdomen, thighs, arms, and chest (16,17). This issue contributes to discontent and poses physical and psychosocial challenges affecting the health and functional well-being of post-bariatric patients. In this context, it is worth noting that at least 70 % of adults report excessive redundant skin (ERS) after bariatric surgery (18-22), and numerous studies have reported an increased prevalence in physical (e.g., skin irritation, pain, infections), psychosocial (e.g., disgust, shame, anxiety), and daily activities (e.g., personal hygiene, dressing) disturbances (18-23). Therefore, addressing ERS is a necessary and crucial step to enhance the quality of life in post-bariatric surgery patients (24-32). For this reason, this study aims to report the results of laser-assisted liposuction in a patient with excessive redundant skin and residual adipose tissue after Roux-en-Y gastric bypass.

Case Description

A 38-year-old female patient with a Grade II obesity history (Weight: 104 kg, Height: 1.69 meters; BMI of 36.49 kg/m^2) and impaired fasting glucose (105 mg/dL), and a Roux-en-Y gastric bypass (RYGB) in January 2022. She lost ≅ 45 kg in the seven months following the surgery, reaching a stable BMI of 20.70 kg/m^2. Nevertheless, the patient visited our aesthetic surgery clinic because she was dissatisfied with abdominal skin excess and sagging in her arms, posterior chest, breasts, and inner thighs (Panel 1A), and she sought improvement in her appearance. Due to those mentioned above, the patient was scheduled for a comprehensive evaluation to plan how to solve her aesthetic problem.

During the first medical consultation, a complete medical history was performed, paying special attention to cardio-respiratory examination, endocrine system evaluation, obesity comorbidities, and skin disease rule-out. Therefore, in this stage, a thorough inspection was conducted regarding skin thickness, laxity, and lesions, helping to determine the body areas requiring an aesthetic procedure. In this regard, a physical skin examination revealed both breasts displaying an elongated, pendulous, and symmetrical appearance. The sternal notch to nipple distance was 24 cm for the right breast and 23 cm for the left breast, indicating Grade 2 breast ptosis. Abundant redundant skin with evident striae less than 2 cm thick was present around the umbilicus, and the lower abdomen was on abdominal inspection. Palpation revealed a soft, depressible, non-painful abdomen without visceromegaly, confirming an important skin excess and laxity. Both upper limbs exhibit skin excess, particularly on the posterior region of both arms. Lower limbs, while symmetrical, show flaccidity and excess skin on both inner and outer thighs (Panel 1A).



Panel 1. Redundant skin and adipose panniculus evolution at baseline **A:** Patient appearance before laser-assisted lipolysis, front view. A notable presence of surplus skin is evident in the abdomen and arms. Additionally, there is an important residual fat accumulation in the abdomen, hips, thighs, and arms. Furthermore, a bilateral breast elongation required a lift procedure involving the placement of 350 cc implants. **B:** Patient appearance before laser-assisted lipolysis, back view. Similarly, residual lower and upper back, thighs, arms, hips, and buttocks fat accumulation and gynoid lipodystrophy (celullité) are evident.

Cardio-pulmonary examination showed rhythmic heart sounds without murmurs; blood pressure of 125/76 mmHg in the left arm and 123/74 mmHg in the right arm seated, with a heart rate and peripheral pulse of 76 beats per minute. Resting 12-lead ECG shows no abnormalities in routine parameter analysis. Respiratory excursions are full and symmetrical. Lungs resonant to percussion and vesicular breath sounds throughout peripheral lung fields. No rales, rhonchi, wheezes, rubs, or tactile fremitus were normal. The rest of the physical examination and general laboratory studies (Table 1) were within normal limits.

One week later, a second medical consultation with the plastic surgery team was conducted to review the laboratory findings and discuss surgical approaches to resolve her skin excess. Ultimately, a consensus was reached around a Laser-Assisted Lipolysis (LAL). One week later, a preoperative medical assessment by the anesthesiologist was performed before the surgical procedure.

Finally, four days before surgery, the participant underwent a 40-minute external low-level red (650 nm) and infrared (980 nm) with a Lipolaser device (Lipolaser LPL9002™ , Colombia), directly applied to all skin areas to be treated during surgery—this intervention aimed to initiate adipose tissue lysis before the surgical procedure.

Table 1. Preoperative laboratory test

Test	**Result**	**Normal values**
Thyroid stimulant hormone (TSH)	1.71 mLU/mL	0.35-5.1 mLU/mL
Prolactin	28.34 ng/mL	1.2-19.5
Cortisol 8:00 am	9.93 µg/dL	6.4-22.8
Helicobacter pylori IgG	7.03	Negative 9 Undeterminate: 9 - 11 Positive >11
Chlamydia trachomatis IgG	0.93	Negative < 9 Undeterminate: 9 - 11 Positivo mayor a >11
Anti-thyroperoxidase Abs (TPO)	<0.25Ul/mL	0-35
Fasting blood glucose	76 mg/dL	70-110
Total cholesterol	133 mg/dL	≤ 200 mg/dL
Triacylglycerides	48 mg/dL	≤ 150
Uric acid	3.1 mg/dL	Women: 2.6 - 6 Men: 3.5 - 7.2
Antiestreptolisines	49.5 Ul/mL	≤ 200
Blood cell count		
Total white blood cells	3,540	4.0 - 10.0
% Neutrophils	55.7 %	39.3 - 73.7
% Lymphocytes	34.8 %	20 – 40
% Monocytes	7.6 %	4.40 - 12.7
% Eosinophils	1.5 %	0.600 - 7.30
% Basophils	0.4 %	0.00 - 1.70
% MID (Mean Inflammatory Distributor)	0.0 %	0.0 - 6.0
Lymphocytes	1.23 $x10^{e3}$/µL	0.8 - 4.0
Neutrophils	1.98 $x10^{e3}$/µL	1.63 - 6.9
Monocytes	0.27 $x10^{e3}$/µL	0.240 - 0.790
Eosinophils	0.05 $x10^{e3}$/µL	0.030 - 0.440
Basophils	0.01 $x10^{e3}$/µL	0.00 - 0.80
MID (Mean Inflammatory Distributor)	0.00 $x10^{e3}$/µL	0.18 - 0.24
Red Blood Cells	4.15 $x10^{e3}$/µL	5.22 - 6.02
Haemoglobin	12.2 g/dL	13 – 17
Hematocrit	36.1 %	39 – 52
Mean Corpuscular Volume	86.9 fL	82.0 - 96.0
Mean Corpuscular Hemoglobin	29.4 pg	26.0 - 32.0
Mean Corpuscular Hemoglobin Concentration	33.8 g/dL	31.0 - 38.0
Red Cell Distribution Width	14.1 %	11.5 - 14.5
Platelet Count	210 $x10^{e3}$/µL	150 – 450
Mean Platelet Volume	12.0 fL	7.0 - 11.0
Plateletcrit	0.253 %	0.108 - 0.282
Platelet Distribution Width	15.6 10(GSD)	11.5 - 17.0
Prothrombin time	12 sec.	12 - 19
Partial thromboplastin time	32 sec.	25 - 33

Operative stage

Preliminary preparation. Following a 12-hour fasting period, general anesthesia with profound sedation was administered. Subsequently, the designated areas for intervention were marked, rigorous asepsis and antisepsis procedures were done in all surgical regions, and surgical drapes were meticulously positioned to maintain sterility.

Areas selected for intervention. The addressed regions in this study were as follows: 1. Abdomen, 2. Lumbar region; 3. Anterior and posterior (dorsal) thorax (with pexy and breast prosthesis placement in women), 4. Arms and, 6. Legs.

Patient setup. In the case of the lumbar region approach, the patient was placed in a prone decubitus position. The surgical table was set at an angle inducing slight vertebral column flexion to optimize access to the lumbar region. Subsequently, incision sites were marked along the maximal subcutaneous fat fold axis. For the abdominal region approach, the patient was positioned in a supine decubitus position with a slight hyperextension, and a substernal incision was made to provide easy and secure access to the costal margin and the upper hemi-abdominal region.

Additionally, two small incisions were made at the suprapubic line to access the lower hemi-abdomen, and bilateral incisions were made in both the flanks and iliac crest. In the case of the anterior chest, incisions were made at the axillary level, and for the posterior chest, two incisions were made at the scapular and infrascapular lines. In the legs, incisions were made on both the inner part of the thighs and knees. In the case of the gluteal regions, the first incision was on the top of this region, and the other one was in the lower gluteal line. In the case of face LAL, two incisions were made at the infraauricular zone and chin.

Tumescent Solution Infiltration. A 1 to 2 mm incision was made with a N° 11 scalpel, followed by an atraumatic cannula insertion and intradermal infiltration with a solution prepared with one adrenaline ampoule diluted in 1 000 cm^3 of 0.9 % NaCl solution within an infusion bag at 150 mmHg pressure and 200 cm^3/minute infiltration rate. The needle movements were deliberately slow to ensure optimal tissue expansion.

Laser-assisted lipolysis. LAL includes several devices with varying wavelengths targeted to cause a selectively fat photo-thermolysis. This study employed a multifrequency laser lipolysis device (Lipolaser LPL9002™, Colombia) for the entire procedure. This low-power cold laser device has wavelengths of 532, 650, and 980 nanometers. This equipment complies with international safety standards for electro-medical devices (IEC 601-1) and laser equipment (IEC 825) (Table 2).

Table 2. Some Lipolaser LPL9002 technical features.

Laser	Features	Main effect
Green	A 532 nm wavelength diode-pumped solid-state laser (DPSSL) and beam diameter at the focal point of 3 mm.	Vasoconstriction
Red	This 650-670 nm wavelength laser has a combination of gallium (Ga), aluminum (Al), and arsenic (As) within the active semiconductor (GaAlAs) and a beam diameter at the focal point of 3 mm.	Adipocyte lysis
Infrared	This 980 nm wavelength laser has a combination of gallium (Ga), aluminum (Al), and arsenic (As) within the active semiconductor (GaAlAs), with a beam diameter at the focal point of 3 mm.	Skin tightening

All regions underwent the same four-step technique as follows:

a. Green laser application. Green laser therapy is the first in laser-assisted lipolysis. Its primary function is vasoconstriction induction, which reduces bleeding and the likelihood of fat embolus formation. The laser device is introduced through a 2 mm caliber cannula, followed by slow forward and backward cannula movements within the subcutaneous adipose tissue, initially in a deep plane, then in an intermediate plane, and finally in the superficial plane.

b. Red laser application. This wavelength laser aimed to induce adipocyte lysis, resulting in the release of triacyl glycerides. From a clinical point of view, the perception of the change in fat consistency by palpation (from a solid to a liquid phase) and the absence of resistance to the laser cannula passage indicates complete adipose tissue liquefaction.

c. Fat evacuation via vacuum device. Liquid fat was aspirated using a suction device (Wells Johnson Co. Tucson, AZ, USA) with 3- 5 mm straight and curved cannulas. Slow movements were performed in the same order as during laser application, starting in the deep plane and concluding in the superficial plane. Overall, this process is minimally traumatic, resulting in the collection of liquefied, yellowish fat with minimal to no blood.

d. Subdermal skin stimulation by Infrared Laser. This wavelength laser's function is skin tightening, resulting in its adhesion to the underlying muscle. The technique was the same as in the red laser for 3 to 6 minutes in each treated area.

Early Postoperative Follow-Up

After the surgical procedure, the incisions were sealed with Micropore® tape and covered with sterile gauze and dressings. Subsequently, a low-pressure elastic bandage was applied. After that, the patient was promptly transferred to the recovery room and closely monitored for 4 hours while undergoing a liquid food tolerance test. The patient progressed satisfactorily during the first twelve-hour period, maintaining her vital signs within normal ranges. She did not experience any complications, which led to her discharge 12 hours after surgery.

Postsurgical care sessions were initiated on the second day, encompassing hyperbaric chamber treatments, external laser therapy, pressotherapy, and a 5-minute drainage routine over five days. The patient underwent daily evaluations for ten days and monthly assessments for the subsequent three months.

Postoperative Follow-Up

During the three-month postoperative follow-up, the patient had a satisfactory progression without local or systemic complications attributable to the procedure.

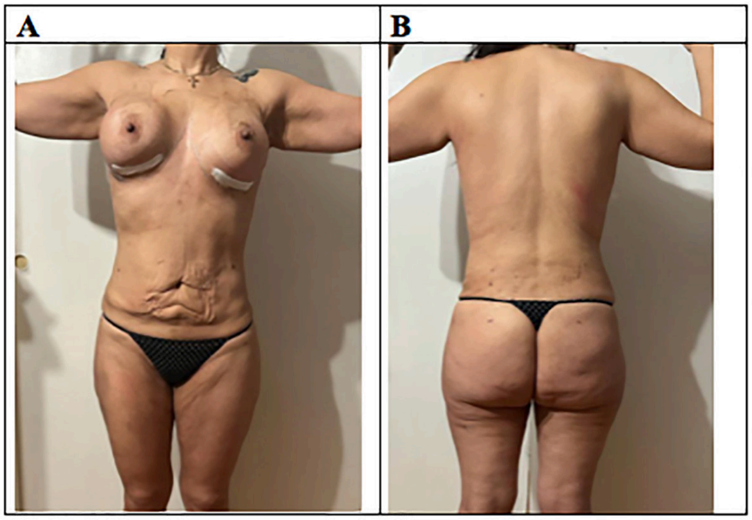
Panels 2 to 3 show the impressive aesthetic improvement in the abdomen, arms, breasts, hips, and thighs due to fat tissue reduction and substantial skin tightening. It is important to highlight that the procedure left no visible scars in any surgically intervened areas.

DISCUSSION

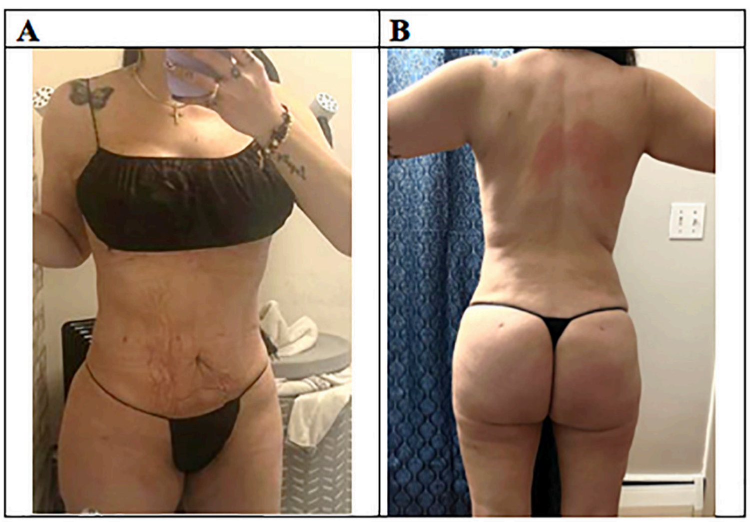
Patients who have undergone massive weight loss face a unique aesthetic challenge due to skin redundancy and lingering fat, often resulting in visible deformities, frequently requiring the address of excess skin and fat by surgical excision (27,28). This approach addresses functional, dermatological, and psychological issues by restoring a more aesthetically pleasing contour. Notably, available evidence suggests that 70 % to 90 % of these patients express a desire for post-bariatric plastic surgery (27,29), but unfortunately, only 10 % have access to such interventions (18-21,27).

The early surgical procedures to address skin and fat excess included surgical excisions such as abdominoplasty, breast lift, brachioplasty, thigh lift, and lower body lifting. However, these procedures pose the drawback of extensive scars replacing the redundant skin, leading some patients to decline such interventions (17, 30). Fortunately, in the last 20 years, new medical technologies and surgical approaches have effectively addressed this issue, particularly refinements in liposuction and photonic treatments. In this regard, Laser-Assisted Lipolysis (LAL) is commonly used for unwanted fat removal and skin reduction (33,34).

Since its Food and Drug Administration (FDA) approval in 2006, there has been an explosive development of medical lasers with different wavelengths (924, 968, 980, 1 064, 1 319, 1 320, 1 344, and 1 440 nm) that have eventually been employed for lipolysis and



Panel 2. A: Redundant skin and adipose panniculus evolution one month after LAL **A:** Front view. A significant decrease in redundant skin is observed in the abdomen and arms compared with the Panel 1 photograph. A reduction in abdominal, leg, and hip fat is evident. The lift procedure with implant placement resolved breast elongation. **B:** Back view. A considerable decline in fat depots can be observed in the lower and upper back, thighs, arms, hips, and buttocks. There is an excellent improvement in gynoid lipodystrophy (celullité) in both gluteal regions.



Panel 3. Redundant skin and adipose panniculus evolution three months after LAL **A:** Front view. A complete redundant skin and residual fat disappearance is observed in the abdomen. **B:** Back view. Fat depots in the lower and upper back, thighs, arms, hips, and buttocks show an important decline compared to baseline and month one. The gynoid lipodystrophy (celullité) in both gluteal regions is still improving.

skin tightening (35-39) and mostly studies have supported the initial clinical observations in adiposity reduction, shorter recovery times, and improved skin retraction (40-43). In this regard, the Lipolaser LPL9002™ device employed in this clinical case has the advantage of three low-power cold lasers at wavelengths of 532, 650, and 980 nanometers, with no need for external cooling during the surgery, thus reducing the burn risk (44,45). This is the first device combining three (Multifrequency) low-potency level lasers for subdermal use during large-volume lipolysis and tissue-tightening treatment. Unlike external lasers, Lipolaser delivers its energy directly to the adipose tissue. An additional advantage of this technology is external therapy laser outputs at the same wavelengths for preparative skin surface application (46,47).

The rationale behind these wavelengths is the specific effects on adipose tissue and skin (48); Green 532 nm DPSSL laser effectively stimulates clothing in small vessels, thus promoting hemostasis during surgical procedures (49-51). Its ability to be absorbed by hemoglobin in blood vessels allows for precise and controlled small blood vessel sealing, minimizing blood loss, contributing to hematomas and ecchymosis prevention, faster postsurgical recovery, and enhancing patient comfort (52-54). Additionally, the DPSSL laser enables greater precision when working in delicate areas near important blood vessels, especially in body contouring and facial aesthetic surgeries with minimal thermal damage to surrounding tissues, ensuring a better surgical experience and improved recovery (55). On the other hand, the GaAlAs 650 nm red laser has demonstrated the ability to cause selective fat cell lysis during the lipolysis procedure, allowing a massive fat extraction with minimal tissue trauma (56). Alternatively, although the infrared GaAlAs 980 nm laser has been employed to break selectively fat cell membranes, this wavelength's main feature is stimulating skin's collagen formation, contributing to a skin-tightening effect (57-59).

In this vein, it can be stated that the overall effect of these three different wavelength lasers involves fat liquefaction, small blood vessel coagulation, increased fibroblast proliferation, and neo-collagen synthesis stimulation, resulting in skin tightening and increased tissue elasticity (60-62). There is a noteworthy aspect beyond lipolysis; skin volume reduction is perhaps the most significant advantage of laser lipolysis (63-65) because massive weight loss is often accompanied by structural protein alterations characterized by reduced levels of heparan sulfate, perlecan, and an increase in collagen-type III (66-68). In fact, differences in protein profiles between patients with substantial weight loss without surgery and those post-bariatric surgeries have confirmed different skin structural phenotypes, suggesting a personalized approach in the selection of body contouring techniques.

It is now widely accepted that heparan sulfate can interact with various biomolecules, inducing biological activities such as cell proliferation, inflammation, hemostasis, and angiogenesis (68,69). For example, perlecan, also known as basement membrane-specific heparan sulfate proteoglycan core protein (HSPG) or heparan sulfate proteoglycan 2 (HSPG2) interacts with various growth factors, including vascular endothelial growth factor (VEGF)-A, essential for the epidermal formation (68,69). During Obesity and post-bariatric weight loss, perlacan concentration and physical properties could be altered, making skin less resistant to tension, for example, along the sutures line, increasing the risk of wound dehiscence, abnormal healing, and infection (70-71). On the other hand, differences in the expression of Collagen Type XIV Alpha 1 Chain (COL14A1), periplakin (PPL), and vinculin (VCL), proteins directly related to the structural composition and mechanical properties of cutaneous tissue, constitute a set of molecular alterations responsible for the distinct clinical characteristics observed between post-bariatric skin laxity (72,73). For example, COL14A1, which plays a central role in regulating the biomechanical properties of the skin, showed lower expression in post-bariatric surgery, suggesting an acquired deficiency of this collagen after bariatric surgery. COL14A1, associated with fibril-like collagen with an interrupted triple helix, controls fibrillogenesis and coordinates the structural organization of collagen types I, III, and V. In this context, PPL and VCL, among other proteins functioning in tissue architecture and regulating mechanical properties of cutaneous tissue and cell adhesion, also showed lower expression in post-bariatric surgery patients (72). PPL plays a key role in protecting and providing resistance to cutaneous tissue, while VCL is essential in the structure and function of focal adhesions and junctional complexes. Reduced availability of PPL and VCL significantly affected the regulation of stiffness in both static stabilization strength and the transmission of intercellular contractile forces, worsening skin laxity (75-80). Therefore, this patient group requires a different and comprehensive therapeutic approach, including managing expectations related to the final aesthetic outcome based on specific clinical skin characteristics, preoperative protein supplementation protocols to improve skin conditions, development and application of techniques allowing greater removal of excess skin, and understanding changes in the skin's protein profile. Thus, the challenges of post-bariatric body contouring surgery go beyond the technical development needed to remove large amounts of excess skin.

It is noteworthy that skin tightening continues to improve several months after laser lipolysis due to the delayed nature of neo-collagenesis. This effect was observed in the present clinical case, where the final tightening effect was fully observable by the third month postoperatively. The results were excellent from an aesthetic standpoint and satisfaction, as the patient did not require a second session to achieve the desired body contour. However, it should be noted that additional skin tightening sessions may be necessary depending on factors such as age, genetics, and skin condition due to environmental factors such as smoking and sun exposure.

Laser-assisted lipolysis (LAL) offers excellent patient tolerance, rapid recovery time, reduced postoperative pain, bruising, edema, and dermal tightening. These are significant advantages of LAL compared to conventional liposuction methods (74). The coagulation of blood and lymphatic vessels and the aspiration of liquefied fat by the laser through small cannulas with less subsequent trauma may explain these benefits.

In the author's experience, complications have been a rare event. Future considerations will include more precise laser and light devices, improved technology, and a reduced side effect profile. Specifically for laser lipolysis, treatments will optimize energy production while minimizing side effects, accelerating recovery, and improving operator time.

CONCLUSION

Patients with massive weight loss have real aesthetic concerns that must be addressed effectively, definitively, and safely. They exhibit varying skin redundancy, fat involution, and localized hypertrophy persistence. Traditional methods to address these problems involved excision, lifting, and even volumetric reconstruction. These procedures inevitably result in a patient transitioning from a high body mass index to a low body mass index but with the marks of scars. Laser lipolysis techniques with skin tightening represent a recent era in plastic surgery that has demonstrated efficacy and safety in body contouring for patients without massive weight loss.

Conflict of Interest: The authors declare no conflicts of interest.

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