1470-nm Radial fiber-assisted liposuction for body contouring and facial fat grafting

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Abstract

Background: Laser-assisted liposuction using 1470-nm radial fiber emits light energy preferentially absorbed by water, yielding a rapid and localized contouring and tightening effect, with minimal scarring. When collected under appropriate conditions, extracted fat samples can be exploited as autologous filling material in liposculpturing procedures.

Objectives: To assess the 6-month contouring efficacy of 1470 radial fiber-assisted liposuction and the volumetric enhancement effect of the harvested tissue in facial fat grafting.

Methods: Twenty subjects underwent liposuction (BeautiFill, Alma Lasers, Inc.) of lower abdominal or outer thigh fat. In seven subjects, harvested samples were grafted into facial regions. Treatment safety, body weight, blinded evaluator-assessed aesthetic improvements, and subject-rated satisfaction were monitored for 6 months. Abdominal and facial fat thickness were assessed by magnetic resonance imaging (n = 5) within 3 months of treatment.

Results: One-month posttreatment, most subjects ranked improvements good/excellent (88%) and skin tightening satisfactory/very satisfactory (92%), with >70% of subjects providing similar scores 6-month posttreatment. Blinded evaluators noted improved/very much improved aesthetic appearance (87%). Harvested tissue injected as a facial filler (21.0 ± 5.2 ml) led to a 0.63 ± 0.12 mm increase in facial fat thickness, observed by MRI, within 3 months. Six months postfilling, the majority of subjects (83%) were satisfied with the outcome. All procedures were well-tolerated.

Conclusions: A single 1470 nm radial fiber-assisted abdominal and thigh liposuction session provided for effective and durable reduction of adipose tissue deposits, with appreciable skin tightening and aesthetic improvements. The gentle harvesting method yielded viable filler material, which was well-retained in facial regions for up to 6 months.

KEYWORDS
1470 nm, body contouring, fat grafting, liposuction, laser-assisted
1 | INTRODUCTION

Liposuction is currently the gold-standard procedure for minimal invasive body contouring and sculpting, and is the second most commonly performed elective plastic surgery procedure, accounting for 16.3% of the procedures performed in 2018 by plastic surgeons across the world. Contemporary liposuction techniques rely on a range of forces to disrupt and harvest subcutaneous adipose deposits, with the choice of technology often driven by patient characteristics and surgeon preference. For example, ultrasound-assisted liposuction (UAL) technology has been shown to enable deep and superficial fat emulsification, providing for improved skin retraction and overall appearance, without damaging surrounding vasculature and tissue. Yet, the technique is time-consuming, due to the separate emulsification and skin tightening steps, and involves a steep learning curve. In addition, complications related to this procedure included hyperpigmentation, seromas, nodular fibroses, and burns. Similarly, water-assisted liposuction emits thin, fan-shaped jets of tumescent solution, which loosens fat cells, with minimal collateral damage to surrounding soft tissue. Cannula dimensions and the shear stress applied provide for adjustment of the depth and aggressiveness of the process, which is generally considered gentle, but largely lacking in subsequent skin contraction.

Laser-assisted liposuction (LAL), founded on localized thermal and micromechanical lipolysis of targeted tissues, affords removal of large volumes of fat deposits from both superficial and deep layers. Its selective photothermolytic effect is mediated by subcutaneous chromophores receptive to specific laser wavelengths, which subsequently dictate the penetration depth and scatter profile, with high-absorption lasers providing a localized effects, while low-absorption lasers elicit more diffuse responses. The resulting thermal injury triggers a healing process involving localized neocollagen deposition and subsequent skin thickening and contraction over the region of the aspirated adipose tissue. Moreover, when compared with traditional mechanical liposuction, the laser-based method liquefies connective tissue more evenly, and elicits thrombosis of blood vessels and closure of lymphatic channels, translating to more uniform results and minimal bruising and downtime. The 1470 nm laser emits light energy preferentially absorbed by water but with less tissue penetration and scatter as compared with shorter wavelength lasers. As a result, it induces a rapid and localized contouring effect, with the lower thermal impact sufficient to induce tissue tightening, with minimal scarring.

When collected under appropriate conditions, extracted fat samples can be exploited as autologous filling material in liposculpturing procedures, avoiding the complications associated with allogenic fillers and implants. Autologous fat transplantation has become a popular filling material, particularly in the face and hands, largely due to its circumvention of complications associated with allogenic fillers and implants, high and simple accessibility, cost-effectiveness and host compatibility. However, it often suffers from limited longevity, hypothesized to be largely determined by the number of viable preadipocytes in the grafted material.

The 1470 nm LipoLife platform (Alma Lasers, BeautiFill by LipoLife™) employs a unique radial emitting laser fiber that has no contact with the tissue since it is located inside a closed blunt Mercedes cannula and results in a soft thermal effect. This renders it ideal for gentle fat tissue collection and consequently reducing the risk of burns and internal scarring. Furthermore, it has been shown to harvest tissue with high relative ratios of viable adipocytes, with few contaminants, seemingly optimal for fat grafting procedures.

The present multi-center, open-label, prospective study aimed to assess the safety and 6-month contouring efficacy of LipoLife 1470 nm radial fiber-assisted liposuction of abdominal and outer thigh fat regions, as well as the volumetric enhancement effect of the harvested tissue in autologous facial fat grafting.

2 | METHODS

2.1 | Subjects

Adult individuals (n = 20) with excessive lower abdominal or outer thigh fat interested in undergoing LAL, and with a BMI ≤35 and without signs of severe skin laxity, were recruited to this study. Smokers, pregnant women, individuals with an active infection in the treatment area or who had recently used anticoagulants or nonsteroidal antiinflammatory drugs for >7 consecutive days, or with history of an autoimmune disorder, keloid scarring, immune system disease or connective, metabolic or atrophic skin disease, were not eligible to participate in the study.

2.2 | Study design

This study was multi-center, prospective, open-label, single-arm study. The study was approved by the ethics committee of each participating site; Sanctuary Medical Center IRB approval (Pro000288811) and Shamir (Assaf Harofeh) Medical Center Helsinki approval (0159-18-ASF). Procedures were performed at the Sanctuary Plastic Surgery (SPS, Florida, USA) or Shamir (Assaf Harofeh) Medical Center’s plastic surgery department (AHMC, Israel), only after subjects provided their signed, informed consent (including photo consent). In several subjects (n = 7) liposuction was followed by facial fat grafting (at least 5 cc). At the USA site, subjects also underwent magnetic resonance imaging (MRI) within 3 months of the procedure to assess abdominal fat thickness and facial fat volume. A presurgery evaluation was performed on all subjects 1 week before the procedure. Frontal, back (when relevant), 45-degree, and 90-degree position photographs of the target area were captured.

Preoperative antibiotic was administered at the physician’s discretion. Tumescent lidocaine (≤45 mg/kg) was locally administered 20–30 min prior to the procedure. Adipose tissue was then harvested using the LipoFlow suction and the LipoDiode 1470 (Alma Lasers, BeautiFill by LipoLife™) using continuous wave mode. Samples of harvested fat tissue were sent to an external laboratory.
for cell viability assessment (Tel Aviv Sourasky Medical Center, Israel) using the Trypan blue exclusion-based fat cells assay as previously described. For facial fat grafting, harvested adipose tissue was collected using fat grafting sterile kit (Alma Lasers, BeautiFill by LipoLife™) at least 5 cc harvested adipose tissue was injected into the target site, including cheeks, temples, and nasolabial regions, using standard equipment. One day of hospitalization was required at the AHMC site. At discharge, subjects were recommended to rest for 2 weeks, rinse the surgical area with water and soap and wear an abdominal/thigh compression garment for the following 4–6 weeks. To assist with the surgical recovery, patients were told to sleep with their head elevated and to take acetaminophen as needed.

Follow-up evaluations, which included assessment of adverse events, body weight measurement, and photography of the treated area, were performed 1, 3- and 6-months postsurgery. In addition, at these same visits, subjects were asked to rate improvement using a 5-point Likert’s scale, with “1” indicating no improvement and “5” indicating “excellent improvement.” Subject overall satisfaction and satisfaction with skin tightening were rated on a 5-point scale, where “1” indicated “very dissatisfied” and “5” indicated “very satisfied.” Subjects were also asked to rate their likelihood to recommend the treatment to friends and family on a scale ranging from “1 – extremely unlikely” to “5 – extremely likely.” Subjects who had undergone a pretreatment MRI assessment were referred for a repeat assessment at the 3-month follow-up visit.

A panel of three blinded plastic surgeons were presented with a set of photos which they were asked to label as “before” or “after” and to grade using the 5-point global aesthetic improvement scale (GAIS), where “1” indicates optimal cosmetic results and “5” indicates worsened appearance as compared with baseline.

### 2.3 | Statistical analyses

Statistical analysis was performed using MedCalc statistical software. Data are presented as mean ± standard error of the mean (SEM). Paired student’s t-test was used to calculate p values; a p-value <0.05 was considered statistically significant.

### 3 | RESULTS

In total, 20 subjects were enrolled in the study, all but two of whom were female (Table 1). Average participant age was 44.3 ± 2.3 years and weight and BMI were 78.0 ± 3.1 kg and 28.5 ± 0.7 kg/m², respectively (Table 1). All subjects were non-smokers and of overall good health. Liposuction procedures were performed in the lower abdomen and thigh (n = 5), lower abdomen only (n = 6) or outer thigh only (n = 9), aspirating a mean volume of 2.2 ± 0.2 L fat tissue. The procedures were well-tolerated, with procedure-related expected side effects limited to one mild case of liquid colonization in the treated left thigh, which was resolved by liquid suction using a syringe. The average cell viability counts were found to be extremely high (97 ± 0.01% per 1 ml lipoaspirate (n = 7)).

In 92% of cases, before and after body contouring photos were correctly classified by the three expert blinded surgeons (Figure 1). In 87% of the 25 treated areas, posttreatment appearance was ranked, by the blinded surgeons as improved to very much improved, at 1-month posttreatment, with scores remaining stable over the 6-month follow-up period (Table 2). The vast majority of subjects (88%) ranked improvements in the appearance of the treated site and their satisfaction levels, as good/excellent and satisfied/very satisfied respectively, at 1-month posttreatment (Table 3). The trend of high improvement and satisfaction scores was stable over the 6-month follow-up period. One month after the procedure, the skin tightening effect was rated satisfactory to very satisfactory by 92% of subjects, feedback that remained similar over the subsequent 5 months in 72% of cases. Four weeks after the procedure, all subjects claimed they were very or extremely likely to recommend the liposuction procedure to family and friends, feedback which remained consistent in 84% of the participants by the end of the study. MRI assessments performed on five subjects after 3 months demonstrated a 1 ± 0.3 cm (n = 5, p < 0.05, data not shown) reduction in abdominal thickness with no reduction in body weight (Figure 2). By the end of the 6 months follow-up period all subject body weight had dropped by 2.2 ± 0.5 kg.

In seven cases, harvested fat was immediately injected as a facial filler, at volumes averaging 21.0 ± 5.2 ml per subject (Figure 3). Posttreatment MRI evaluation of facial fat grafting areas identified a statistically significant increase in fat thickness (0.63 ± 0.12 mm) within 3 months of treatment, indicating sustained fat viability following implantation (Figures 4, 5). Physician-evaluated facial grafting outcomes at 1 month were rated satisfactory in 76% of the cases and declined, although not statistically significant, over the 6-month follow-up period. The majority of subjects (83%) scored their improvement level and satisfaction from the procedure as good/excellent and satisfied/very satisfied, respectively, at 6-months posttreatment (Table 4). All subjects reported that they would be extremely likely to recommend the liposuction procedure to family and friends, feedback which remained consistent throughout the follow-up period.

### 4 | DISCUSSION

Advances in LAL are continuously improving procedural safety and long-term outcomes. Particularly, introduction of the 1470 nm into the aesthetic surgeon toolbox has enabled gentle and effective localized extraction of excess fat deposits, of ideal quality for subsequent grafting applications. In the current study, 1470 nm radial fiber-assisted liposuction of abdominal and thigh regions yielded discernible improvements, which were well sustained over the 6-month follow-up period. Subject satisfaction with the procedure and its skin tightening effect was consistently high throughout the study. Further, the liposuctioned adipose tissue samples sent for analysis, contained a high percentage of viable preadipocytes, which would account for the enhanced fat thickness over the 3 months following their implantation into facial regions. In turn, subject satisfaction...
### TABLE 1  Patients’ demographics, baseline characteristics and procedure details

| Subject Number | Site   | Age | Weight (Kg) | BMI  | Gender | Liposuction area | Energy (KJ) | Lipoaspirate volume (L) | Facial Fat Grafting volume injected (ml) | Fat vitality assessment amount of fat (ml) |
|----------------|--------|-----|-------------|------|--------|-----------------|-------------|-------------------------|----------------------------------------|------------------------------------------|
| 1              | Israel | 43  | 61.0        | 22.7 | F      | Thighs          | 18.97       | 1.31                    | NA                                     | NA                                       |
| 2              | Israel | 44  | 72.5        | 29.2 | F      | Abdominal&Thighs| 27.58       | 2.45                    | NA                                     | 87                                       |
| 3              | Israel | 22  | 99.0        | 31.0 | M      | Abdominal       | 31.44       | 1.90                    | NA                                     | 70                                       |
| 4              | Israel | 55  | 85.2        | 30.5 | F      | Abdominal       | 21.31       | 2.05                    | NA                                     | 97.5                                     |
| 5              | Israel | 47  | 66.5        | 26.8 | F      | Abdominal       | 30          | 2.50                    | NA                                     | NA                                       |
| 6              | Israel | 47  | 93.8        | 35.3 | F      | Thighs          | 51.63       | 3.62                    | NA                                     | 120                                      |
| 7              | Israel | 45  | 73.0        | 25.9 | F      | Thighs          | 34          | 1.87                    | 4                                      | 100                                      |
| 8              | Israel | 37  | 63.5        | 24.0 | F      | Thighs          | 25          | 2.50                    | NA                                     | 110                                      |
| 9              | Israel | 29  | 72.0        | 26.8 | F      | Thighs          | 17.85       | 2.40                    | NA                                     | NA                                       |
| 10             | Israel | 53  | 71.8        | 28.4 | F      | Thighs          | 12.24       | 2.20                    | NA                                     | 300                                      |
| 11             | Israel | 40  | 86.1        | 28.1 | F      | Abdominal       | 34.17       | 3.00                    | NA                                     | NA                                       |
| 12             | Israel | 53  | 83.8        | 33.3 | F      | Thighs          | 25.7        | 3.06                    | 6                                      | NA                                       |
| 13             | Israel | 43  | 88.0        | 28.7 | F      | Thighs          | 15          | 3.10                    | NA                                     | NA                                       |
| 14             | Israel | 39  | 78.4        | 32.5 | F      | Thighs          | 13          | 2.05                    | NA                                     | NA                                       |
| 15             | Israel | 46  | 73.0        | 27.5 | F      | Abdominal       | 15          | 2.40                    | NA                                     | NA                                       |
| 1              | USA    | 65  | 74.8        | 29.2 | F      | Abdominal&Thighs| 15.81       | 3.00                    | 41                                     | NA                                       |
| 5              | USA    | 45  | 73.5        | 27.0 | F      | Abdominal&Thighs| 15          | 1.90                    | 25                                     | NA                                       |
| 6              | USA    | 57  | 61.0        | 28.3 | F      | Abdominal&Thighs| 10.19       | 1.20                    | 34                                     | NA                                       |
| 7              | USA    | 48  | 67.1        | 24.4 | F      | Abdominal&Thighs| 15.77       | 0.60                    | 23                                     | NA                                       |
| 8              | USA    | 28  | 116.2       | 30.4 | M      | Abdominal       | 21          | 1.50                    | 14                                     | NA                                       |
| Average±SEM   |        |     | 44.3 ± 2.3  | 78 ± 3.1 | 28.5 ± 0.7 |            | 22.5 ± 2.3 | 2.2 ± 0.2               | 21 ± 5.2                               | 126.4                                    |
with grafting outcomes was unanimously high throughout the follow-up period. An added value came in the form of the average 2 kg weight loss measured in subjects by the end of the 6-month follow-up period, likely the result of improved psychosocial well-being and body image, motivating subjects to adhere to desirable lifestyle changes, including exercise regimens and careful diets.

The degree of photothermal effect on adipose tissue highly depends on the internal tissue temperature, with temperatures of 50–65°C destroying adipocytes and inducing tissue necrosis and scarring. Due to the high water absorption coefficient of the 1470 nm illumination wavelength, relative gentle heating of the adipose tissue suffices to induce lipid release and reduce tissue viscosity, enabling easy suction of large volumes of fatty deposit with no adipocyte rupture. The localized, controlled, and reversible thermal injury also imparts a hemostatic effect, achieved via small blood vessel coagulation, keeping blood loss and subsequent bruising at a minimum, overcoming two major limiting factors of conventional liposuction procedures. At the same time, it coagulates fibrous tissue and stimulates a healing response, involving fibroblast recruitment and subsequent collagen neosynthesis, and remodeling. A wavelength-dependent dermal response was demonstrated in several works, where low-energy lasers generally

### TABLE 2

| GAIS score of 1-3 | Average (3 physicians) | 1 M FU | 3 M FU | 6 M FU |
|------------------|------------------------|--------|--------|--------|
| No. of treatment areas | 21.7 | 20 | 20.3 |
| % | 87 | 80 | 81 |

FIGURE 1  Clinical outcomes of 1470 nm radial fiber-assisted liposuction Representative photographs of outer thighs and lower abdominal regions before and 3 months after 1470 nm radial fiber-assisted liposuction. Up: Female – 43 years old, total aspirate of 1.31 L removed from the thighs. Below: Female – 55 years old, total aspirate of 2.05 L removed from the abdominal area.
TABLE 3 Subject Satisfaction – Percent with Likert Scale Score 4–5

| Subjects' assessment of Improvement | Subject Satisfaction | Satisfaction from skin Reaction (Tightening) |
|------------------------------------|----------------------|---------------------------------------------|
| 1 M FU                             | 3 M FU               | 6 M FU                                     |
| 1 M FU                             | 3 M FU               | 6 M FU                                     |

liposuction procedure % Patients with Likert scale 4–5 (n = 25 treatment areas)

88 88 84 88 84 88 92 84 72

FIGURE 2 Abdominal fat thickness Representative MRI photographs of the lower abdominal region, before and 3 months after 1470 nm radial fiber-assisted liposuction showing reduction of −1.77 cm in abdominal fat thickness (the line indicates the abdominal fat thickness). Female – 65 years old.

FIGURE 3 Clinical outcomes of facial fat grafting Representative photographs of subject before and 3 months after grafting in the cheeks, nasolabial folds and temples with adipose tissue harvested via 1470 nm radial fiber-assisted liposuction. A – 45 degrees to the Left, B – 45 degrees to the Right. Female – 48 years old.
had a more extensive skin tightening effect as compared with higher energy lasers, possibly related to the end temperatures or to the targeted subdermal chromophores. In contrast, non-thermal lipid harvesting techniques fail to stimulate adipocyte collagen deposition and to firm sagging skin and its underlying structures. LAL in general, and 1470 nm LAL, in particular, achieves favorable and durable skin retraction outcomes, broadening treatment site criteria to include any region with even modest degrees of skin laxity.

In addition to the inherent benefits of the 1470 nm laser, the unique design features of the LipoLife platform further ensured its advantageous safety and tolerance profiles. More specifically, its radial configuration reduces emission intensity throughout the surgical field, further lowering risk of burns and internal scarring, while preserving adipocyte viability, and its rounded tip and small cannula size minimize tissue trauma. When applying the LipoLife 1470 nm radial diode laser for Teimourian grades I–II arm contouring in a single-session laser lipolysis procedure, Leclere and colleagues reported on an average 4.7–5.5 cm decrease in arm circumference ($p < 0.01$), and an average skin pinch decrease of 2.1 cm and 2.9 cm among grade IIa and IIb patients, respectively. Patient-evaluated pain was minimal, and mean downtime was shorter than 1 day. The same group reported on a 26.6-degree reduction in cervicomental angle following LipoLife treatment in patients presenting Rohrich type IV aging neck. When deployed to address gynecomastia, LipoLife liposuction brought to mean chest and areola diameter reductions of 11.93 cm and 1.80 cm, respectively, 6 months posttreatment ($p < 0.05$), without inducing any complications, skin burns, edema or areolar congestion. Similarly, Nicoli et al. report on significant decreases in upper limb circumference in 10 patients with chronic advanced upper extremity lymphedema undergoing lymph node flap transfer in combination with 1470 nm LAL.

Traditionally, liposuction techniques have been differentiated by safety, consistency of outcomes, operator effort, and downtime. Yet, today, the quality and viability of the extracted sample has become a highly relevant parameter as well. Indeed, extraction techniques have been shown to yield differential adipocyte viability, generally proving low when mechanical trauma and/or chemical reagents are
involved. Following an up to 17-year follow-up of the long-term results of facial injections of mechanically collected autologous fat material performed in 1720 patients, Dasiou-Plakida reported on an estimated 20–30% resorption within 4–8 weeks and 40–60% resorption within 12–24 months of implantation. Others have reported on even higher resorption rates, leaving clinical outcomes highly unpredictable. The gentle thermal effect of the 1470 nm laser has been correlated with homogenous extracts enriched with viable preadipocyte content and low fibrous tissue and blood content in the implanted fat material, central determinants of resorption rates. Indeed, when applied here in autologous fat transfer procedures for skin rejuvenation and volume enhancement, a durable filling effect was achieved.

The current study design was limited by the small sample size, the relatively short follow-up period, as well as the non-controlled analyses. Controlled, long-term studies monitoring the durability of response are still needed.

5 | CONCLUSION

A single 1470 nm radial fiber-assisted liposuction session for abdominal and thigh contouring, provided for gentle yet effective reductions in adipose tissue deposits, which proved durable for at least 6 months. The gentle thermal effect triggered clinically appreciable skin tightening, which translated an improved cosmetic appearance as reported by both physicians and subjects. Furthermore, the harvesting technique yielded a viable adipocyte-rich autologous facial filler material, which was well-retained in the implantation site.

ClinicalTrial.gov ID MCT03800563, https://clinicaltrials.gov/ct2/show/NCT03800563

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CONFLICT OF INTEREST

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

AUTHORS’ CONTRIBUTIONS

All authors’ have read and approved the final manuscript. L.H., S.M., L.P., O.S.A. and J.N.P. performed the research. L.H. and J.N.P designed the research study. S.M. analyzed the data. L.P. wrote the paper.

ETHICAL STATEMENT

The study was approved by Shamir Medical Center Helsinki committee, Israel (0159–18-ASF, Approval date: 21 Aug 2018) and by ADVARRA IRB, USA (Pro00028811, Approval date: 17 Sep 2018). The study was registered on www.clinicaltrials.gov; NCT03800563.
DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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