Histological differences between laser-assisted and suction-assisted lipoplasty aspirates – a comparative study

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Abstract

Introduction: The authors aimed to assess the histological differences between the traditional suction-assisted lipoplasty (SAL) and the more recently developed laser-assisted lipoplasty (LAL) aspirates, in a 20-case comparative study. Patients and Methods: Between March of 2011 and March of 2012, we operated on 20 healthy female patients seeking body contouring procedures of the abdomen, flanks and outer thighs, all having good to moderate skin tone and moderate to heavy adipose deposits and no previous treatment of the interested areas. After initial aspiration of a 100 mL sample of fat tissue through the SAL technique, we applied the LAL protocol, using a Lipolite device with a 1064 nm Nd:YAG laser, again sampling the aspirate for histological study. Results: The analyzed samples revealed significant histological difference between the two aspirates: the adipose tissue architecture, after conducting the LAL procedure, appeared to be disrupted, consisting of deformed and ruptured fat cells surrounded by coagulation-modified collagen, small lymphocytic inflammatory infiltrate, coagulated small blood vessel and intact nerves. In contrast, the cytological patterns of the adipose tissue after using the SAL technique resembled normal fat tissue structure. Conclusions: Our study succeeded in demonstrating significant histological differences between SAL and LAL aspirates, many of which could explain certain disparities between the clinical outcomes of the two procedures.

Keywords: laser-assisted lipoplasty, suction-assisted lipoplasty, coagulation-modified collagen, fat cells disruption, histopathological study.

Introduction

Liposuction, also known as lipoplasty, has succeeded in becoming the most frequently performed cosmetic surgery procedure during the last decade, in both men and women, managing to depose the very popular breast surgery procedure during the last decade, in both men in becoming the most frequently performed cosmetic

The cornerstone in the development of today’s modern suction-assisted liposuction (SAL) was Klein’s introduction of the tumescent technique, which consists of very precise amounts of lidocaine and epinephrine buffered with sodium bicarbonate being added to the saline. This resulted in a major reduction of per procedural complications such as hematoma, ecchymosis and edema, as well as improved pain management during and after the procedure, leading to decreased necessity for general anesthesia and the possibility to perform the procedure in an outpatient setting rather than a hospitalized environment [4, 5].

Alongside the increasing demand for body contouring procedures, the last decade has witnessed the emergence of technical variants of the traditional procedure, all aiming to obtain better clinical results, less tissue damage and adjacent complications [6].

Among these, besides the classical SAL, prominently noted have been: ultrasound-assisted and external ultrasound-assisted liposuction (UAL – emulsifying the adipose tissue using ultrasound prior to suction), power-assisted liposuction (PAL – using a specialized cannula with mechanized movement), laser-assisted liposuction (LAL – melting the adipose tissue through laser application, making it easier to be withdrawn), vibration amplification of sound energy (VASER – ultrasounds are delivered in a pulsed fashion rather than continuously) [7, 8].

To this date, several studies [9–12] both prospective
and retrospective, have investigated one specific technology or technique, but it has been difficult to compare different devices or procedures. The primary aim of our study is to assess the histological differences between LAL and SAL techniques.

Patients and Methods

The protocol was approved by the ethics committee of the “Prof. Dr. Agrippa Ionescu” Clinical Emergency Hospital, Bucharest, Romania. Patients’ informed written consent was obtained from all participants being included in the study.

Between March 2011 and March 2012, we operated on 20 healthy female patients seeking body contouring procedures of the abdomen, flanks and outer thighs, all having good to moderate skin tone and moderate to heavy adipose deposits in the targeted areas, with a mean age of 28.3 years (ages ranged from 22 to 51 years), with BMI (body mass index, kg/m²) values from 20 to 30 and no previous treatment of the involved areas.

Preoperatively, a strict protocol was followed for each patient. After blood samples were drawn, the involved areas were photographed, surgically marked and measured.

After initial intravenous sedation, the first step of the procedure consisted of the tumescent infiltration (Klein modified solution: 1 L saline, 40 mL 1% lidocaine, 1 mg of adrenaline), followed by a waiting period of 20 minutes. Next, we harvested 100 mL of adipose tissue from the entire marked area by using SAL, as a comparative sample for pathology. Afterwards, we initiated the deep LAL treatment phase of the area according to the established protocol. Through the same 2 mm incision used for the insertion of the SAL cannula, we introduced the 550 μm optical fiber through 100 mm, 150 mm and 200 mm cannulas by means of which we delivered 50 Hz/12 W/4 kJ per one 10×20 cm area, followed by manual control of tissue softness and optional 10% additional dose if the initial one was deemed insufficient. Once the desired consistency was achieved, we proceeded with the extraction of the emulsified fat (sampled for pathology) through 2 or 3 mm cannulas, until the sought after shape was obtained. Subsequently, we proceeded with the shallow LAL phase, applying 15 Hz/12 W/2 to 4 kJ per area of 10×20 cm, while continuously monitoring the skin temperature with a laser thermometer. Steri Strips, absorbent dressing and compressive garment were used for wound management.

Postoperative care included the use of compression garments for six weeks, antibiotic therapy, analgesics and deep vein thrombosis prophylaxis. Follow-up visits were conducted on day 1 and 7 post-operative and one, three and six months after the surgery.

The technical specifications of the device we employed are presented in Table 1.

<table>
<thead>
<tr>
<th>Technical specifications</th>
<th>Pulse rate</th>
<th>100–800 μs</th>
</tr>
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<tbody>
<tr>
<td>Laser type</td>
<td>Nd:YAG</td>
<td></td>
</tr>
<tr>
<td>Laser wavelength</td>
<td>1064 nm</td>
<td></td>
</tr>
<tr>
<td>Pulse energy</td>
<td>Up to 800 mJ</td>
<td></td>
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<tr>
<td>Aiming laser</td>
<td>635 nm (red) diode</td>
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The main target of our study was to assess the histological differences between the samples harvested after carrying out SAL and LAL procedures.

Post-laser-assisted and suction-assisted lipoplasty infranantサンプルの100 mLを採取し、送られ、われわれの病理学者に評価された。

The obtained samples were fixed using a buffered 10% formaldehyde solution for a 24-hour period at room temperature. Afterwards, the specimens were automatically processed by means of a tissue processor (HISTOS 5 MW) with a JFC isopropyl alcohol solution and then embedded in paraffin. Sections of 3 μm in thickness were cut out from the paraffin block and placed on slides, followed by the Hematoxylin–Eosin (HE) staining process.

The immunohistochemistry (IHC) was performed on 3 μm sections from 10% formalin-fixed paraffin-embedded tissue samplings according to the IHC method, an indirect biatdial technique, performed with a polymer-based detection system (BrightVision Poly-HRP-Anti MS/Rb/Ra IgG, Immunologic, The Netherlands). Tissue sections were spread on poly-L-Lysine-coated slides, immersed in three changes of xylene, and dehydrated using a graded ethanol series. Antigen retrieval was performed using a microwave oven. In each section, endogenous peroxidase was blocked through incubation, which was conducted in 3% hydrogen peroxide for 20 minutes. The sections were incubated with primary antibodies: S100 protein (Cell Marque, 1:500, 4C4.9), CD34 (Dako, 1:50, QBend10) and α-SMA (alpha-smooth muscle actin) (Cell Marque, 1:500, 1A4) in a room-temperature environment, for one hour. The BrightVision Poly-HRP-Anti MS/Rb/Ra IgG was then applied for 30 minutes. Finally, the sections were incubated in a 3,3'-diaminobenzidine (DAB) solution for 8 minutes, counterstained with Mayer’s Hematoxylin and afterwards mounted.

Results

Histopathological study

Following surgery, we took photographs of both aspirated specimens and compared them in terms of macroscopic aspect. While the SAL-specimen presented with a darker yellow color and more structured fat, the LAL-specimen had a more homogenous aspect, a lighter yellow color and visible fat vesicles (Figure 1).

Microscopic evaluation revealed significant differences between the SAL and LAL-extracted fat. The adipose tissue architecture, after conducting the LAL procedure, appeared to be disrupted, mostly consisting in deformed and ruptured fat cells (Figure 2) surrounded by coagulation-modified collagen (Figure 3), small lymphocytic inflammatory infiltrate (Figure 4) coagulated small blood vessels (Figure 5) and intact nerves (Figure 6).

In contrast, cytological patterns of the adipose tissue
after using the SAL technique tended to resemble normal fat tissue structure, presenting mostly with intact cell membranes, intact blood vessels and small amounts of fibrosis (Figure 7).

The IHC evaluation conducted on the post-LAL aspirates revealed several notable findings: significant immunostaining with anti-S100 monoclonal antibodies exposing adipocyte membrane rupture (Figure 8), blood vessel wall disruption shown by an increased expression of α-SMA (Figure 9); the hematopoietic progenitor cell antigen CD34 was also reported as it was found adhering to the vascular endothelial cells (Figure 10).
While the existing comparative studies between SAL and LAL have found only subtle differences with regard to the clinical aspects, both procedures scoring roughly the same on Strasser’s objective grading system [13], histological discrepancies are obvious, most of them explaining the advantages of one technique over another and vice-versa.

It has been stated out that patients undergoing body-contouring procedures using SAL are prone to developing higher degrees of ecchymosis, edema, blood loss and pain, requiring a longer recovery period [14].

In comparison, the apparent clinical benefits of LAL could be explained through the hypothetical sparing effects of the Nd:YAG laser on lymphatic and blood vessels and on the nerves [13, 15, 16].

In support of this theory, some of the more prominently noted of our histological findings have been the significantly higher nerve integrity and the important degree of small blood vessel coagulation.

Concerning the cosmetic results in terms of the alleged skin tightening effect of LAL, the results published so far have been debatable: DiBernardo et al., in a 10-patient study comparing LAL and SAL, reported a statistically significant outcome on skin retraction in the abdominal area [17]. Sasaki published two different reports in 2009 and 2010, the first one being a two-year study of 75 cases of LAL for facial and body contouring and tissue tightening, which failed to demonstrate a significant degree of skin retraction [18], while the latter combined two laser wavelengths (1064 nm/1320 nm Nd:YAG laser) and confirmed the skin tightening effect in the abdominal area [19].

Our histological study found coagulation-modified collagen and lymphocytic inflammatory small infiltrates, pleading for the theory of new collagen induction [20, 21] and final skin tightening.

Regarding the possible use of the aspirate for fat grafting, our results favor the SAL procedure sample, which presents with normal adipose tissue architecture and intact cell membranes, while the LAL sample revealed fat cell disruption and rupturing, making it unsuitable for such a purpose.

However, a recent review of the literature regarding fat graft survival pointed out the importance of two major factors that play a critical role in the final outcome of this specific procedure [22–24].
Histological differences between laser-assisted and suction-assisted lipoplasty aspirates – a comparative study

Histological findings indicate that the endurance of the transferred adipocytes alone may not be fully responsible for the long-lasting effect of the grafted areas, yet, when achieved, more stable or permanent results are usually attributed to the inflammatory reaction following fat injection, which generates a significant amount of connective tissue that acts primarily as a solid scaffold to achieve tissue consolidation. This theory, called “the host replacement theory”[26, 27] indicates that LAL aspirates may also be used for fat grafting procedures, with substantial odds of attaining the sought after contour, without having to worry about transient results[22, 28, 29].

Conclusions

Our study succeeded in demonstrating significant histological differences between SAL and LAL aspirates, many of which could explain certain disparities between the clinical outcomes of the two procedures. However, to be proven valid, these findings should be supported by additional prospective, randomized, controlled clinical studies conducted on larger series of patients.

Conflict of interests

The authors declare that they have no conflict of interests.

References


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