

Complications of Liposuction

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1. Introduction

Liposuction, a surgical intervention designed to treat superficial and deep deposits of subcutaneous fat distributed in aesthetically displeasing proportions, has proven to be a successful method of improving body contour. Liposuction is so successful, in fact, that it is commonly performed in the office-based surgery setting. Liposuction is one of the most common surgical interventions carried out by physicians around the world and within the top five surgical procedures in the United States. [1] The procedure is of moderate complexity with a death rate of 1/5000 over all. [2] It is performed by multiple specialties within the aesthetic arena, expanding the possibilities for adverse outcomes.

2. Evolution of liposuction

Since the introduction of liposuction techniques in 1982 the management of adipose tissue for aesthetic and reconstructive purposes had undergone a significant change. [3] The introduction of new techniques such as wet, superwet and tumescent suction assisted liposuction (SAL), [4, 5] as well as the development of new technologies such as power assisted liposuction (PAL), ultrasound assisted liposuction (UAL) and laser assisted liposuction (LAL), broaden the possibilities within the field. The advent of new techniques and technologies is not free of complications and each of these developments has been associated with a subgroup of problems that should not be overlooked.

Over the past decades the safety standards have also developed along with the innovations in the field of liposuction. In the year 2010 over 200,000 liposuction cases have been recorded in the United States alone. [1] In the most recent survey published by Dr. Jamil Ahmad, et al. the vast majority of complications were related to UAL (35.2%), LAL (22.9%), and SAL (22.1%). [6] Another important point of this review is the new trends in the market, which create an indirect pressure on the physician through the patient (consumer). The marketing of new products is poorly regulated and the early release of new technology to the public creates an added risk to the population undergoing these procedures perhaps due to the lack of experience with the product.

The complications can be subdivided in local or systemic. Local complications include contour deformities (irregularities, depressions, undercorrection and overcorrection), hematomas, seromas, alterations of skin color and sensitivity, infection, skin necrosis, *cutis marmorata*, etc. The systemic complications are in general of greater severity and include:

deep venous thrombosis, pulmonary embolism, fat emboli, hypovolemia, edema, toxicity or medication interaction, perforation of abdominal wall or viscera, sepsis as well as the usual complications associated with any other surgical procedures.

3. Prevention

As we experienced and rapid expansion in technology and developments of new techniques over the last two decades the emphasis now has shifted to an essential component of our practice: patient safety. Several meetings with emphasis on patient safety have taken place over the last decade around the world. As in any other portion of the medical field, patient safety is mainly focused on prevention although many times adds recommendations on how to deal with complications when necessary. On the topic of prevention we should outline some of the main resources in the literature and its recommendations for further reference. No strict rules have been set to regulate every specific aspect of the practice of liposuction although several guidelines have been issued to avoid complications. Failure to comply with this guidelines could result in legal actions against practitioners since this have been set over evidence based medicine and are held as the most relevant safety measures in the literature today.

We would like to start by citing the recommendations included in Fatal Outcomes from Liposuction: Census Survey of Cosmetic Surgeons published in the Plastic and Reconstructive Surgery Journal. [7] In this paper the following guidelines are outlined: 1. Appropriate patient selection (ASA class I, within 30 percent of ideal body weight) 2. Use of superwet techniques of infiltration 3. Meticulous monitoring of volume status (urinary catheterization, noninvasive hemodynamic monitoring, communication with anesthesiologist) 4. Judicious fluid resuscitation a. For aspirate less than 5 liters: maintenance fluid plus subcutaneous infiltrate b. For aspirate over 5 liters: maintenance fluid plus subcutaneous infiltrate plus 0.25 ml of intravenous crystalloid per milliliter of aspirate over 5 liters 5. Overnight monitoring of large-volume (over 5-liter total aspirate) liposuction patients in an appropriate healthcare facility 6. Use of pneumatic compression devices in cases performed under general anesthesia or lasting longer than 1 hour 7. Maintaining total lidocaine doses below 35 mg/kg (wetting solution).

1	Quantity of tumescent fluid infused
2	Total dosages and drugs utilized
3	Total volume of fat and fluid extracted
4	Technique utilized
5	Type of anesthesia
6	Volume of supranatant fat
7	Anatomical sites treated
8	Use of ultra-assisted technique (internal of external)
9	Drains (if placed)
10	Complications should be noted
11	Post-operative garments utilized

*From AACS 2006 Update in Guidelines for Liposuction

Table 1. Operative Record for Liposuction

Another important document issued in 2006 by the American Academy of Cosmetic Surgery was an update on the Guidelines for Liposuction, which includes a series of recommendations for the pre, intra and post operative management of the patient undergoing liposuction. [8] Among other suggestions a good systematic approach at data gathering is provided including the information presented in Table 1.

Finally, we would like to conclude the prevention section with one of the latest evidence based medicine documents in the literature published in 2009. [9] This document provides the most up to date information regarding patient safety related to liposuction in an heavily referenced evidence-based structure and is a key paper of the current literature. The paper is a well organized overview of the field of liposuctions that correlates well with the information presented in this Chapter.

4. Complications

4.1 Systemic complications

4.1.1 Deep venous thrombosis and pulmonary embolism

Deep venous thrombosis (DVT) is one of the most feared complications due to its relation to pulmonary embolism (PE) and its fatal consequences. PE is been the main cause of death among patients undergoing cosmetic surgery claiming one forth of the deaths. [10] A thorough preoperative evaluation to identify risk factors of thrombosis and the use of preventive measures (stockings, pneumatic intermittent compression systems, etc) together with early mobilization, appropriate hydration and anticoagulation when indicated are sufficient to prevent venous thrombosis in healthy individuals. During the immediate postoperative period (first 24 hours) is imperative to carry out early mobilization (6-8 hours after surgery) as well as the use of compressive garments. Lymphatic drainage and massage could be considered as adjuvant therapies as well. The symptoms of pulmonary embolism include sharp hest pain, shortness of breath, chest pain that worsens with deep breathing or coughing, coughing up blood, tachycardia, sweating and anxiety.

4.1.2 Hypothermia

Hypothermia has been recognized as a significant factor associated with a broad arrange of complications in the last two decades. It has influence not only in the coagulation system but also affects the immune system as well. Because of this proper precautions have to be taken to prevent excessive heat loss. The use of warming devices, warm fluids and attention to room temperature are the basic steps to prevent hypothermia.

4.1.3 Lidocaine and epinephrine toxicity

Accepted doses of lidocaine are 7mg/kg for lidocaine with epinephrine and 4-5 mg/kg of lidocaine alone. Doses up to 33-35 mg/kg have been reported as safe in the literature when utilized in large volume infiltration as a tumescent solution. [5] The next important factor to consider is the pharmacokinetics of the drug with a peak concentration between 8-12 hours from infiltration. Liver metabolism should be assessed prior to liposuction procedures with lidocaine infiltration since its impairment of drug interference may affect the usual lidocaine clearance with detrimental effects for the patient.

Epinephrine effect also should be considered as an added factor to the overall stress in the procedures. Cardiac function should be interrogated during the history and physical and appropriately evaluated if necessary. Epinephrine use should be avoided in patients who present with pheochromocytoma, hyperthyroidism, severe hypertension, cardiac disease, or peripheral vascular disease. In addition, cardiac arrhythmias can occur in predisposed individuals or when epinephrine is used with halothane anesthesia. Alterations in the rate and force of contraction or cardiac irritability and hypertension can occur, particularly in hyperthyroid patients. [11]

4.1.4 Cardiopulmonary arrest & fluid shifts

Proper pre-operative, intra-operative and post-operative fluid management is essential to optimize the good perfusion and minimize the risk of cardiopulmonary complications and death.

Fluid aspirations should be limited to 5 L per session to avoid the excessive third spacing that could jeopardized the ability to compensate the fluid shifts on the average patient. Other rules are to limit the aspirate to less than 5% of the body weight and treat less than 30% of the body surface

4.1.5 Infection and sepsis

Erythema, drainage or even swelling should not be taken lightly. Local sings of infections should be promptly investigated and treated. Unrecognized or untreated infections could lead to compromise of a large surface area or even to necrotizing fasciitis and other more severe systemic manifestations. Also systemic symptoms without local evidence should be addressed since the risk of perforation of an intra-abdominal organ is always a risk. Careful aseptic technique is essential including skin prep and proper instrument management. Perioperative antibiotics play a significant role in liposuction. Although the procedure may be considered of moderate complexity the total areas treated are usually broad and proper antibiotic delivery during the operations is essential.

4.1.6 Fat emboli

Although of rare occurrence, fat emboli could lead to fatal outcomes. The syndrome presents with a triad of petechial rash, respiratory distress and cerebral dysfunction. The diagnosis is difficult and the treatment is supportive. Corticosteroids may play a role in the management of this rare entity.

4.1.7 Perforation of abdomen and viscera

These complications are frequently related to the lack of proper training. Although it may occur to well-trained professionals, usually undertrained physicians or even non-physicians performing the procedure lack proper anatomical knowledge and soft tissue handling experience. This combination can lead to a catastrophic outcome requiring more aggressive interventions with increase morbidity and even the risk of death. Care should be taken when using power assisted cannulas and even ultrasonic or laser technologies since the tissue resistance changes making easier the penetration of undesired structures. Patient positioning is another important point since might expose areas to undesired trauma during suction lipectomy. The type of cannula is another important considerations since blunt cannulas are safer than small sharp ones.

4.2 Local complications

4.2.1 Hematoma and seroma

Hematoma may result from inappropriate technique or increase-bleeding diathesis from congenital vs. acquired reasons. A careful history and physical will, most of the time, give away any increase bleeding tendencies in a particular patient. The use of wet, superwet or tumescent liposuction has decrease significantly the risk of bleeding after suction lipectomy. Seromas are related to an excessive liposuction with inappropriate postoperative management. The use of compressive garments may provide comfort and at the same time decrease the dead space suitable for fluid accumulation. Lymphatic drainage is usually unaffected with proper SAL although other techniques such as UAL have been associated with an increase risk of seroma formation. Some advocate the use of drains over the first 24 hours incases on large volume liposuction as well as manual drainage.

4.2.2 Surface irregularities

This complication is related to a poor technique in most cases. The violation of anatomical structures and the incorrect level of treatment may result in undesirable outcome. The type and orientation of the cannulas is key as well as the level of suction. With the increase in understanding of the tissue anatomy we can perform a safe procedure removing the reserve fat in the adequate plane.

The treatment of the skin irregularities is challenging and entails the release of the scarred tissue with or without interposition of autologous tissue, such as fat injections, etc. (liposculpture). Preexisting cellulite deformities should be pointed out since these types of deformities are likely to persist after suction lipectomy. Continuous assessment of the tissues by pinch maneuvers or similar is essential to avoid surface irregularities, undercorrection or overcorrection.

Finally the inappropriate use of postoperative garment can result in skin irregularities. Close attention should be given to the post-operative dressings. (Figure 1)

4.2.3 Skin excess

If a large amount of skin excess is expected the procedure should be combined with skin resection. The retractile properties of skin will compensate for a mild to moderate amount of skin excess after suction lipectomy. In most cases the distinction between a poor and a good result comes with experience.

4.2.4 Cutaneous hyperpigmentation

This complication is related to the deposition of hemosiderin derived from degradation of hemoglobin to ultraviolet light. This process causes fixation of the pigments to the superficial layers of the skin. Prevention entails avoidance of sun exposure until ecchymosis is resolved. Often the cases of hyperpigmentation are related to vasculopathies. The use of newer technologies such as LAL has decreased the amount of ecchymosis and hyperpigmentation.

4.2.5 Skin necrosis

If the subdermal plexus is violated or traumatized the overlying skin is prone to necrosis. The more invasive technologies such as UAL and LAL are also at risk of skin burning which will ultimately result in skin necrosis and scarring. Excessive compression from garments can also jeopardize the viability of the treated area. (Figure 2)

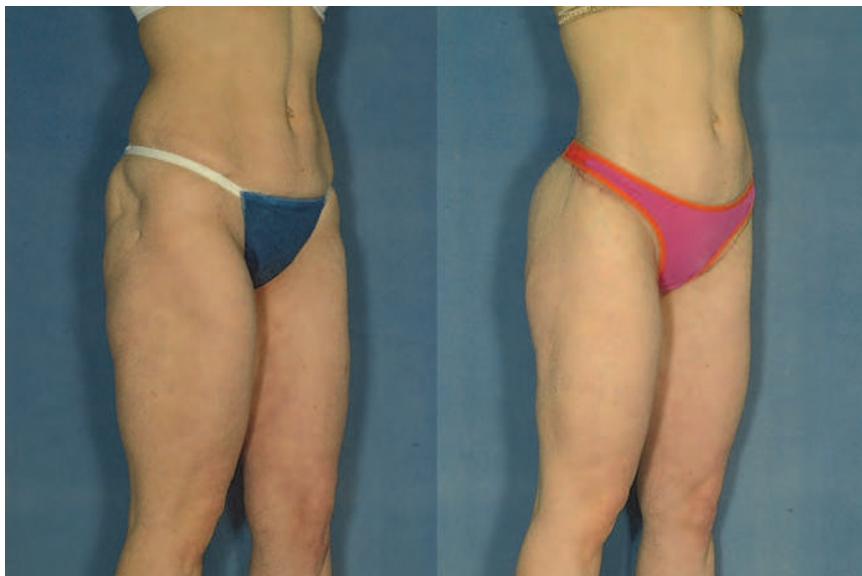


Fig. 1. Skin surface irregularities corrected by spiral lift and rotational dermal-fat flap with fat injection

4.2.6 Skin sensation

Anesthesia, hyperesthesia and dysesthesia are usual manifestation of the procedures. In most cases are temporary with return of normal sensory function within few months.

4.2.7 Cutis marmorata

It is believed that *cutis marmorata* after liposuction is related to trauma to the subdermal plexus resulting in a skin pattern resembling cutis marmorata. These patterns can persist after the operation up to one year.

5. Discussion

A brief historical note and a review of the literature of the last five years are presented in our discussion.

When addressing complications in liposuction is impossible not to mention the earliest and, perhaps one of the worst complications cited in the literature. The concept of removing excess fat from localized body sites to achieve similar gains is credited to Charles Dujarrier, who in France [12-14] attempted to remove subcutaneous fat using a uterine curette on calves and knees of a ballerina in 1921. An inadvertent injury of the femoral artery led to amputation of the dancer's leg. This unfortunate complication arrested further progress in this field and but it was a valiant attempt at the time. [15]

Schrudde in 1964 [14] revived interest in this procedure and extracted fat from the leg, gaining access through a small incision with a curette, but was faced with a daunting task of managing the difficult hematoma and seroma that resulted from this technique. Subsequently, Pitanguy [16] favored an en bloc removal of both fat and skin to remove excess thigh adiposities, but the extensively noticeable incisions did not allow the technique to become popular.



Fig. 2. Periumbilical skin excess, necrosis, and surface irregularities.

Some recommendations to avoid complications related to the different techniques and technologies available are: to prevent thermal injuries while performing ultrasound-assisted liposuction, two technique rules are of critical importance. First, the ultrasound probe or cannula must be kept in motion; second, the infiltrate solution is a required component of ultrasound-assisted liposuction as it plays a crucial role in the process of fat emulsification. Due to the amount of blood loss associated with the dry technique, its use is not recommended except in limited applications with a volume of 100 cc of total aspirate or less. The dry technique should never be used in conjunction with ultrasound-assisted liposuction. No one single liposuction technique is best suited for all patients in all circumstances. Factors such as the patient's overall health, the patient's body mass index, the estimated volume of aspirate to be removed, the number of sites to be addressed, and any other concomitant procedures to be performed should be considered by the surgeon to determine the best technique for the individual patient. Multiple openings facilitate extraction of fat and traumatize the tissue less because repeated movement over a given area is minimized [5, 17]. The selection of the appropriate cannulas is key to avoid adverse outcomes. The design, size, and length of the liposuction cannula vary greatly depending on the area(s) to be suctioned, the type of liposuction performed, and the physician's preference. The diameters of cannulas typically range from 2 to 6 mm and are available in a variety of lengths. [18-21] No one cannula is appropriate for all procedures, patients, or surgeons. PAL is effective for large-volume removals, fibrous areas, and revisions. It is typically used in conjunction with the tumescent or superwet technique. Care should be exercised since the added vibration could result in further complications such as skin trauma and necrosis. The recent introduction of newer technologies such as LAL facilitates the extraction of adipose tissue at the expense of a careful technique since the heat dispersion is higher and a different technical skill needs to be developed to avoid complications. In a recent study LAL showed to be an effective adjunct to liposuction with low complication rate. [22]

Among other rare complications ischemic optic neuropathy [23] as well as self-inflicted postoperative injuries [24] show that even undertaken with all safety precautions, patients and physicians are exposed to complications. Preventive measures, proper patient selection, accurate documentation, and respect for current standards of practice are the minimum requirement for a safe practice.

6. Conclusion

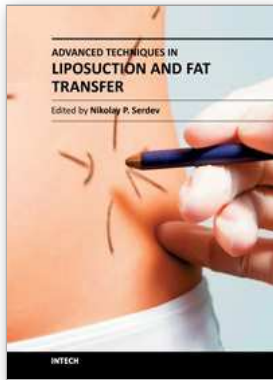
Liposuction is one of the most common surgically performed procedures, and its low complication rate supports the procedure's popularity. A complete preoperative assessment along with a proper training and respect of industry standards is essential to avoid unwanted occurrences. The constant evolution of techniques and technology calls for a dynamic reassessment of the safety standards to keep the patient and physician safe. As physicians we should educate our patients to avoid dissatisfaction and more important, complications.

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Liposuction is the first cosmetic procedure to change beautification surgery from open extensive excision surgery into a more atraumatic closed one. It gave rise to the modern understanding of minimally scarring and minimally invasive surgery and changed the understanding and preferences of both patients and doctors. It also became the most common procedure in cosmetic surgery world-wide, practiced by an increased number of physicians from various specialties. The techniques of fat grafting, closely bound with liposuction, have found widespread application and fat stem cells seem to be changing the future of many areas in medicine. Turning the pages, the reader will find a lot of information about advances, tips and tricks, as well as important milestones in the development of the different methods available, such as classic, power, ultrasound, laser and radio-frequency assisted liposuction etc. Most useful anesthesia techniques are described and discussed, and guidelines have been established for medical indications. Special attention is paid to good patient selection, complications and risks.

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