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Strategies for Reducing Fatal Complications in Liposuction

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Background: Liposuction has become one of the most common cosmetic surgical procedures, and severe complications secondary to this procedure have also increased significantly. That is why we carry out a research work to know the most frequent severe complications reported in the scientific literature to indicate criteria for prevention.
Methods: English-language scientific publications about liposuction and its complications were analyzed using the PubMed.gov, from the beginning of PubMed's history through June 10, 2017. Five terms were used to define liposuction and its complications: "liposuction," "liposuction AND complications," liposuction AND major complications," "liposuction AND complications AND death," and "liposuction AND death." The quantities of results for the 5 phrases were analyzed, along with their contents.
Results: One thousand sixty-three results were obtained from 1973 through June 10, 2017 for the phrase "Liposuction and Complications" in humans; for "Liposuction and Major Complications," 153 articles were found; for "Liposuction and Deaths," 89 articles were found; and 42 articles were obtained with the terms "Liposuction and Major Complications and Deaths." After final depuration, all those that were not specific to severe liposuction complications were eliminated, leaving a total of 39 articles that were included in our study. Five problems proved to be the most serious complications when performing liposuction: Thromboembolic disease, fat embolism, pulmonary edema, lidocaine intoxication, and intraabdominal visceral lesion.
Conclusions: The 5 most important complications that can cause death in liposuction are easily preventable using simple measures and proper safety protocols that are described in this work. *(Plast Reconstr Surg Glob Open 2017;6:e1539; doi: 10.1097/GOX.0000000000001539; Published online 25 October 2017.)*

INTRODUCTION

Liposuction is one of the most frequently performed procedures in plastic surgery. According to worldwide statistics, it represents between 15% and 20% of all surgeries, placing it in the top 3 most requested procedures in the last 5 years.[1,2] Because of its prevalence, there has also been an increase in complications secondary to the procedure. The total complication rate of liposuction is approximately 5%, with most complications being minor.[3–5] However, studies have revealed that deaths secondary to this procedure are as high as 1 in 5,000 surgeries.[6–9] Therefore, a review was conducted to identify the leading serious complications of liposuction and to provide the surgeon with the tools to reduce the risks of such complications occurring.

MATERIALS AND METHODS

English-language scientific publications about liposuction and its complications were analyzed using the PubMed.gov (U.S. National Library of Medicine, National Institutes of Health) database. A literature search was conducted from the beginning of PubMed's history through June 10, 2017. A search was conducted for specific words and phrases in all parts of the articles. The following 5 terms were used to define liposuction and its complica-

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tions: "liposuction," "liposuction AND complications," "liposuction AND major complications," "liposuction AND complications AND death," and "liposuction AND death." Subsequently, the search was refined using filters to obtain only results for humans and review articles for humans based on each phrase. The quantities of results for the 5 phrases were analyzed, along with their contents. For the inclusion and final analysis of the articles, the results were refined by including only those containing data and reviews of major complications (including death) in liposuction. The articles included were analyzed to identify the specific characteristics of the complications, considering etiopathogenesis, causes, clinical presentation, evolution, diagnosis, prognosis, treatment, and prevention.

RESULTS

For the phrase "Liposuction and Complications" in humans, 1,063 results were obtained from 1973 through June 10, 2017; for "Liposuction and Major Complications," 153 articles were found; and for "Liposuction and Deaths," 89 articles were found. All those that were not specific to severe liposuction complications were eliminated, leaving a total of 31 articles that were included in our study. Likewise, the 42 articles obtained with the terms "Liposuction and Major Complications and Deaths" were refined, leaving 25 articles for analysis, many of which were already included in the phrase "Liposuctions and Deaths." A total of 39 articles were included in our study. All search results for the words "Liposuction and Major Complications and Deaths," along with the number of articles found, are shown in Table 1.

DISCUSSION

Liposuction is not a procedure for losing weight; rather, its main goal is to shape and improve the patient's figure. Although fat reduction provides an improvement in the health status of obese patients,[10,11] the high risk of complications in these patients should be considered[12] because there is a very high risk associated with patients who have body mass indices greater than 35 kg/m^2.[13,14]

The most frequent major complications that can lead to death in a patient undergoing liposuction is pulmonary thromboembolism, which represents more than 23% of deaths.[6] The risk factors should be analyzed for each patient to determine the risk of deep vein thrombosis (DVT),[15,16] to assign a prophylaxis protocol for the patient or, if necessary, to postpone or cancel the surgical event. The incidence of thromboembolism in plastic surgery procedures ranges from 0.5% to 9% in different studies performed by the American Society for Aesthetic Plastic Surgery.[17–20] However, in a survey among the members of this society, only 43.7% of the surgeons provided prophylactic treatment for DVT in liposuction, with only 60.8% providing prophylactic treatment when multiple procedures were performed in the same surgery.[21–23] As described by Dr. Virchow, thrombus formation is secondary to a triad of factors—venous stasis, vascular lesion, and hypercoagulability—and only one of these factors is needed to initiate the coagulation process.[24] During a surgical procedure, stasis is promoted due to anesthesia, lying in a supine (dorsal decubitus) position and immobilization. Anesthesia also causes damage to the tunica intima of the veins due to vasodilation and traction of the veins secondary to the retraction of muscles and tissues. Hypercoagulability may already be present in the patient, whether inherited or acquired.[21] Of the DVTs associated with surgery, 50% begin during surgery, most in the distal veins of the calf. Of these DVTs, 50% will resolve spontaneously in 72 hours, whereas 25% of them will extend to proximal thrombosis above the popliteal vein, with evidence of pulmonary embolism in tomography, even when the patient is asymptomatic.[25] The period of greatest risk for a fatal pulmonary thromboembolism is between the third and seventh days post operation. Up to 2/3 of thromboembolisms are asymptomatic, but 10% of those with symptomatic pulmonary thromboembolisms will die within the first hour, with the period of greatest risk for a symptomatic thromboembolism being between the second week and 3 months post operation.[25] There are multiple guidelines and protocols for stratifying the risk of DVT in patients who will undergo surgery. The guide by Caprini is the most accepted, with the one published in 2005 being the most suitable for classifying the risk of DVT in plastic surgery patients.[26] According to the Caprini risk classification, a normal liposuction scores at least 2 points, but this score is rare as many patients accumulate at least 1 additional point. Many liposuctions therefore have a minimum score of 3 points, which is considered a high-risk surgery, and these patients will require pharmacological prophylaxis with low-molecular-weight heparin. Pharmacological prophylaxis can begin between 6 and 12 hours after surgery and continue for 7–10 postoperative days. However, in patients with a very high risk for DVT, prophylaxis can last up to 30–35 days.[27]

Abdominal visceral lesion is a significant complication that can cause death.[6] The incidence of abdominal perforation and visceral damage secondary to liposuction is unclear, and it is therefore important to avoid these complications during surgical procedures.[28,29] Perforation of the ileum is the most common, followed by perforation of the jejunum and spleen and, to a lesser extent, the transverse colon, cecum, and sigmoid colon.[30,31] Factors inherent to the patient may be due to wall defects because of previous abdominal surgeries, diastasis, hernia, obesity, and other factors. In case of suspicion, an abdominal ultrasound should be requested to correctly identify the defects and/or weaknesses.

Table 1. Results from Articles Search: Words Used and Numbers of Articles

Words	General	In Humans	Reviews in Humans
Liposuction	3,834	3,342	416
Liposuction AND complications	1,168	1,063	138
Liposuction AND major complications	178	153	18
Liposuction AND complications AND deaths	42	42	6
Liposuction AND deaths	94	89	9

During the surgical procedure, the most important task of the surgeon is to control the cannula, for both infiltration and aspiration,[28,29] always in a tangential direction and with both tactile and visual control. It is very important to monitor the patient in the first postoperative hours because early diagnosis is vital for the successful treatment of this complication. Problems are suspected when symptoms such as abnormal and severe abdominal pain, persistent nausea and/or vomiting, and the absence of intestinal transit are observed. If an abdominal perforation is suspected, a chest x-ray/abdominal x-ray and abdominal-pelvic tomography should be requested. Treatment should be immediate, with exploratory laparotomy and management of perforations according to their location, size, and time of evolution.[28,32–35]

One of the most important issues is the management of trans-surgical fluid during liposuction, as multiple techniques, including infiltration, preparation, and the transoperative management of solutions, are involved. The incorrect handling of liquids can lead to 1 of 2 situations for the patient: hypovolemia when the replacement is insufficient, or most commonly, fluid overload and the risk of pulmonary edema. Given that approximately 70–75% of the infiltrated solution is absorbed into the bloodstream within 160 minutes after its administration, the infiltration technique used is important, as are the concentrations of epinephrine and/or anesthetics used.[36–38] The superwet technique has been proposed as the safest method.[39] Therefore, the problem of fluid overload is commonly caused by replacement that is administered transoperatively. The most common mistake is to forget that approximately 70% of the infiltrated solution will be absorbed into the central circulation system, so that habitual replacement by the anesthesiologist due to fasting, trauma, and bleeding, in addition to the usual maintenance requirements, results in fluid overload. A study by Rohrich et al. in 2003,[39] in which the requirements for fluid replacement were assessed according to the type of liposuction performed, concluded that transoperative fluids should be replaced with crystalloids, and the total volume administered should account for subcutaneous infiltration and intravenous administration. Therefore, according to this analysis, a ratio of liquids administered according to the total amount liposuctioned is established. This ratio consists of replacing 1.8 ml per cc liposuctioned for a total liposuction volume of less than 5,000 cc and 1.2 ml per cc for a total liposuction volume of more than 5,000 cc, followed by a maintenance of 1.6 cc/kg/hr for smaller volumes and 1.3 cc/kg/hr for larger volumes.[39,40]

The concentrations of local anesthetic in liposuction infiltration solutions have been a subject of constant debate. Studies have demonstrated that lidocaine and bupivacaine, being highly lipophilic, have higher absorption rates of 90–99% in a period of only 10 minutes postinfiltration.[41] However, because of the dilution effects and action of epinephrine, which is commonly used in these solutions, peak plasma concentrations are detected between 8 and 18 hours for lidocaine and 20 hours for bupivacaine.[41] It has also been noted that to avoid intoxication by these drugs, the maximum plasma concentrations are 6 μg/ml for lidocaine and 3–5 μg/ml for bupivacaine.[42] For these reasons, local anesthetic toxicity complications can appear up to 24 hours after surgery. When performing this procedure as an outpatient surgery, symptoms will occur outside of the medical setting, without either the early detection of complications or timely attention. Thus, we recommend that patients remain hospitalized a minimum of 15–24 hours after surgery, as has been reported in other studies.[39] Previous studies have supported the safety of the use of lidocaine concentrations between 35 and 55 mg/kg.[43,44] However, the maximum concentration of lidocaine approved by the United States Food and Drug Administration is 4–5 mg/kg, which is increased to 7 mg/kg if used with epinephrine. Therefore, the use of higher concentrations, combined with the absorption of infiltrated local anesthetics and their slowly increasing concentrations in plasma, carries a risk of intoxication, causing nausea, vomiting, tremors, excitation, psychoses, and muscular fasciculations, which can lead to severe intoxication, accompanied by convulsions and cardiac arrest. We recommend that special care be taken if higher doses are used, as the maximum absorption when combined with epinephrine peaks at 12 hours. Thus, it is recommended that these patients also remain hospitalized between 15 and 24 hours after surgery. According to the American Society of Regional Anesthesia and Pain Medicine guidelines, the management for reversing intoxication by local anesthetics is with a lipid emulsion (Intralipid) as a 1.5 ml/kg bolus in 1 minute followed by an infusion of 0.25 ml/kg/min, which is continued until 10 minutes after the patient is stabilized.[45]

Although significant quantities of epinephrine are administered in liposuction, a plasma level that can be classified as toxic has not been identified, although the manufacturers' recommendation is not to exceed the 0.6 mg dose subcutaneously, and 0.5 to 1 mg intravenously every 5 minutes is recommended in resuscitation events.[46] The purpose of epinephrine is to produce vasoconstriction and to delay the absorption of local anesthetics and thus prolong the duration of their effects. Normal levels of epinephrine in the blood are less than 100 pg/ml, with an extra-short half-life of approximately 2 minutes, and their peak levels of concentration are seen between 2 and 4 hours after infiltration.[47] Studies have suggested a safe dose of 1 mg of epinephrine per liter of infiltration, with a limit of 10 L of infiltration, which would give a total infiltration of 10 mg of epinephrine, where epinephrine absorption is only 25–32% of the administered dose,[48] and total doses as high as 7 mg epinephrine in a single procedure raise the plasma concentration of epinephrine to 3 times its normal concentration (286–335 pg/ml). No side effects of epinephrine toxicity were observed. However, it is suggested that patients who are more susceptible to epinephrine or those with undetected heart disease may experience toxicity effects.[49] Although the studies show relative safety with the use of epinephrine in high doses, it should be remembered that the normal plasma levels of epinephrine are being tripled. This increased concentration may represent a great risk; therefore, we recommend preoperative cardiac evaluation of all patients and the controlled and moderate use of epinephrine.

Fat embolism (FE) occurs in up to 8.5% of patients undergoing liposuction, and we must differentiate between 2 pathologies: fat embolism syndrome (FES) and macro FE. All patients who have undergone a liposuction of a volume equal to or greater than 900 ml present lipid macroglobulinemia and are therefore susceptible to FES. In FE, macroscopic fragments of fatty tissue are the cause of pulmonary thromboembolism and may or may not be associated with FES.[50,51] The cause of the presence of fat microembolisms in the bloodstream after liposuction is trauma to the soft tissues and blood vessels of the area treated. FES is a syndrome of variable severity and is identifiable by its signs and symptoms. Onset is usually gradual, with respiratory, neurological, and cutaneous involvement, which, on average, are presented between 48 and 72 hours after the triggering event. The most accepted theory of the etiopathogeny of FES is endothelial lesions on the walls of small capillaries because of the presence of free fatty acids in the bloodstream, which are very irritating.[52] Adequate hydration is indicated as a factor that protects against the appearance of FES.[53] There are multiple theories associated with FES, with the hypovolemia theory being the most accepted with respect to the liposuction procedure because it predisposes the patient to circulatory stasis and to the formation of microaggregates.[4] The exterior of fat microembolisms offers a surface to which these microaggregates and activated platelets can adhere, causing a macroscopic (> 3 cm) embolism that can produce a mechanical obstruction.[54] Hydroelectrolytic decompensation predisposes the patient to FES, which is one more reason why it is important to maintain adequate fluid balance and to monitor vital signs in the patient's first postoperative hours following liposuction. The main cause of FE is direct trauma to medium- and/or large-caliber vessels, which may occur during the liposuction process itself or because of the lipoinjection process, a procedure that is commonly performed concomitantly with liposuction, as discussed in the article by Cárdenas-Camarena et al.[55] in 2015, in which deaths secondary to gluteal lipoinjection were analyzed; this procedure represents a serious risk of FE. Recommendations have been made including infiltrating with cannulas greater than 3 mm in diameter, performing infiltration gently, and avoiding risky approaches such as the subgluteal crease. Deep intramuscular injection is the most important risk factor favoring the appearance of an FE, for which, unfortunately, the prognosis is almost always fatal.[40]

CONCLUSIONS

According to the analysis performed, the following conclusions and recommendations are offered:

1. Because liposuction often represents a Caprini score of 3 or greater, to minimize the risk of thromboembolic disease and pulmonary thromboembolism, a thorough evaluation of the risk of developing thromboembolic disease is necessary to determine the need to administer pharmacological prophylaxis.
2. Lidocaine must be used in infiltration solutions in the smallest amount possible. If the recommended dose of 7 mg/kg is exceeded, special care is recommended, as the maximum absorption when combined with epinephrine peaks at 12 hours. In these cases, the patient should remain hospitalized for up to 24 hours after the procedure.
3. The amount of IV fluids to be administered during liposuction is minimal. Consideration should be given to the recommendations for the administration of liquids according to the amount of liposuction performed, as high proportions of subcutaneously infiltrated liquids are absorbed into the bloodstream.
4. Although it is acceptable to administer 1 mg of epinephrine per liter of solution used in tumescence, it is not recommended to exceed an amount greater than 10 mg total.
5. Although epinephrine is relatively safe during liposuction when administered at the indicated dose, it is highly advisable to perform preoperative cardiac evaluations of all patients to identify predisposing factors that could determine severe side effects.
6. Because both lidocaine intoxication and pulmonary edema can occur during the postoperative period, it is recommended that the patient remain hospitalized for a minimum of 15–24 hours after surgery.
7. It is of utmost importance to maintain adequate patient hydration during the trans- and postoperative periods to protect patients against FES and FE.
8. Deep intramuscular injections into the gluteal region should be avoided, especially in the medial portion adjacent to the piriformis muscle, to avoid injuring gluteal vessels. The use of cannulas smaller than 3 mm in diameter must also be avoided, as these are more likely to injure the gluteal veins.

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