

Safety of Ultrasound-Assisted Liposuction: A Survey of 660 Operations

Niloufar Roustaei · Seyed Jafar Masoumi Lari ·
Majid Chalian · Hamid Chalian ·
Hooman Bakhshandeh

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Abstract

Background Ultrasound-assisted liposuction (UAL), although providing some advantages over tumescent liposuction (TL) and traditional or suction-assisted liposuction (SAL), has been found to have some controversial complications. We performed this study to evaluate UAL's complications and to compare UAL with the previous routine techniques for liposuction.

Methods Six hundred sixty UALs were performed on 609 consecutive volunteers by one cosmetic surgeon. Demographic characteristics, local and systemic complications, and also severe adverse events (SAE) were registered intraoperatively and at 1, 4, and 12 weeks postoperatively.

Results No SAEs were identified and only nine complications, consisting of two systemic complications (two cases of hypotension) and seven local complications (3 seromas, 3 cases of contact dermatitis, and 1 case of hemorrhage), were registered. This yields a complication incidence of 1.36%. There was no association between the number of complications and the body region, age, gender, or body mass index (BMI).

Conclusion Our findings are in line with others in that performing UAL using local tumescent anesthesia is a safe procedure with a very low complication rate and has remarkable advantages over other liposuction techniques (TL and SAL). In addition, there was no correlation between the incidence of complications and body region, age, gender, or BMI.

Keywords Ultrasound-assisted liposuction · Complication · Safety

Liposuction, technically called lipoplasty, is one of the most popular cosmetic procedures currently performed by dermatologic surgeons and plastic surgeons [1–5]. It is also the most frequently performed cosmetic surgery procedure in the United States, performed on over 100,000 American people annually [6].

Since the introduction of liposuction in the late 1970s, numerous modifications have been made to the original idea to make it more effective and also to reduce possible complications [7]. Currently, liposuction comes in three forms: traditional (or suction-assisted) liposuction (SAL), tumescent liposuction (TL), and ultrasound-assisted liposuction (UAL). In SAL, the surgeon passes a hollow suction tube, “cannula,” through small incisions in the area where the fat is to be removed. Moving the cannula around, the surgeon mechanically breaks up the fat, which is then suctioned out by a mechanical pump or syringe. TL is essentially the same as SAL except for the large volume of fluid that the surgeon introduces into the area to be liposuctioned. The fluid, which contains local anesthetic and blood-vessel-constricting drugs, helps to reduce blood loss, alleviate pain, and lessen the need for general anesthesia.

N. Roustaei · S. J. Masoumi Lari · M. Chalian
Iran University of Medical Sciences, Tehran, Iran

N. Roustaei (✉)
Unit 1, No. 5, Kazemian Alley, Shariati St.,
1913633913 Tehran, Iran
e-mail: ualclinic@gmail.com

H. Chalian
Tehran University of Medical Sciences, Tehran, Iran

H. Bakhshandeh
Department of Epidemiology and Biostatistics, School of Public
Health, Medical Sciences/University of Tehran, Tehran, Iran

The latest in liposuction is UAL. The seminal difference between UAL and TL is that UAL uses the energy of high-frequency sound waves to liquefy the fat before it is removed with low-pressure suction.

UAL, a relatively new surgical innovation available to Iranian surgeons, provides some advantages over SAL such as less injury to nerves and blood vessels, less overall tissue trauma, minimized blood loss, smaller-diameter channels formed in the adipose tissue, smooth tunnels created in adipose tissue, more even shaping of overlying skin surfaces, accurate positioning of probes, and spot-specific tissue removal [8]. There are also some reported advantages for UAL over TL including less damage to the vascular and nervous structures, reduced bleeding, less bruising, swelling, and discomfort with more skin retraction at the postoperative stage, and less physical effort for the surgeon [9–12]. In contrast to these positive claims are some complications with controversial frequencies ranging from skin necrosis and burns (caused by the heat of the ultrasound device), fat necrosis and fibrosis, hyperpigmentation, sensory alteration (thought to result from sensory nerve damage by ultrasound), postoperative ecchymosis, and postoperative swelling [13] to more devastating complications such as severe abdominal wall necrosis [14] and even death [15].

The goal of this study was to evaluate UAL's complications in our patients and to compare UAL with the previous routine techniques for liposuction. We also evaluated the association between the number of complications and body region, age, gender, and BMI as possible predictors.

Patients and Methods

Patients and Data Collection

In a prospective study, 660 UALs performed on 609 consecutive patients in the largest liposuction center in Tehran, Iran, during a 6-year period starting from January 2002 were included. The nature of UAL was explained to the patients and the purported benefits, risks, and potential complications were reviewed. Medical malpractice insurance and special UAL consent was obtained from all patients before surgery.

Patient demographics and general data, including age, gender, educational level, and marital status, and clinical data such as BMI, site of liposuction, and number of operations per patient were retrieved from patient records. There were also follow-ups for all patients in clinic at 1, 4, and 12 weeks postoperatively.

Literature articles were reviewed for previously reported complications associated with liposuction. Local

complications included skin or subcutaneous infection, permanent skin irregularity, seroma, hemorrhage, allergic contact dermatitis to tape, skin ulceration or necrosis, permanent sensory nerve damage, unacceptable scars, and persistent postoperative edema. Systemic complications included allergic reaction to oral or intramuscular medication, febrile reaction, systemic infection, cardiac arrhythmia, tachycardia, anemia, blood or fluid loss requiring a transfusion, pulmonary or fat emboli, hypotension, hypovolemic shock, peritoneal or thoracic perforation, seizures, thrombophlebitis, and death [5, 14, 16].

The number of severe adverse events (SAE), defined as requiring hospitalization or intravenous therapy, including thromboembolism, abdominal/thoracic wall or viscus perforation, sedation/medication reaction or toxicity, cardiorespiratory failure, cardiac arrhythmia/tachycardia requiring treatment, pulmonary edema, hypovolemic shock, massive infection (local/systemic requiring intravenous therapy), hemorrhage requiring blood transfusion, lidocaine toxicity, or skin ulceration/necrosis, and deaths were also registered.

Surgical Technique

The patients were marked in a way that identified the areas to be treated with UAL with circles and an X over prominences. Areas with asymmetries, dimpling, or indentations were also marked. Standard photography was performed after marking and after surgery. All cases were performed with preoperative uniform subcutaneous infiltration of the wetting solution in the intermediate surgical plane using a standard subcutaneous infiltration pump and cannula. The amount of infiltrate delivered was recorded. The infiltrate was delivered in a "superwet" technique with a 1:2 ratio of infiltrate to estimated aspirate [17, 18]. The infiltrated solution was based on 1 l of room-temperature Ringer's containing 25 cc of 2% xylocaine, 2 cc of epinephrine in a concentration of 1:1000, and 8 cc bicarbonate 8.2 mEq/L. Equipment consisted of an ultrasound generator (Sonoca-Lipo, Soring, Germany) operating at about 25 kHz and a 4.5-mm hollow titanium cannula (Liposuction-handpiece 240). Although the largest cannula typically used for liposuction is 3 mm, we used a 4.5-mm cannula because smaller ones were not available.

The incisions for the access sites for UAL were carefully placed because the scars could be noticeable and the surgeon should be able to treat multiple areas from the same site without causing the cannula to be bent or torqued. After the incision was made, a plastic trocar was inserted and a large cover mat was placed to prevent thermal injury from the cannula. The cannula was inserted into the skin protector (trocar) and treatment began. The cannula was in

motion at all times to prevent heat buildup and thermal injury. The UAL's energy was stopped in an area about 1–2 cm from the access site to prevent repetitive overtreatment at this site and potential fat necrosis.

Aspiration was performed at 70% of usual vacuum and a 3.5-mm standard fine surgical suction cannula (Suction cannula, SIEVE) was used for evacuation and final contouring of the treatment area. Any remaining asymmetries, deformities, or bulges were treated at the time. After final contouring, manual digital massage of the treated areas was performed and a pinch test was done by holding the skin and fat between the thumb and the fingers to determine the amount of fat, its mobility, and the degree to which the enlarged area is due to a localized superficial fat deposit. Access incisions were usually left open to allow egress of fluid during the first 24–48 h, but some were closed with a single 5–0 chromic suture in cases in which they were very wide. Dressings and compression garments were applied. Two sets of compression garments were given to the patient, and the first set was changed the day after the operation, worn continuously for 1 month, and during daytime only for 2 months thereafter.

Statistical Analysis

Statistical studies were carried out using the SPSS v11.5 (SPSS, Inc., Chicago, IL, USA). Quantitative data were expressed as mean $\pm$ SD (standard deviation). Complications were reported as the percentage from total liposuction body regions or total complications wherever suitable. A Poisson regression model fitted to determine the adjusted associations between the numbers of complications, as a dependent event, and the body region, age, gender, and BMI, as predictors, was used.

Results

Six hundred sixty UALs were performed on 609 patients (mean age = 47.6 ± 9.3 years, females = 569) who were referred to our center. Sociodemographic characteristics of our study population are given in Table 1. The average body regions treated per patient was 1.1. Procedure time ranged from 75 to 420 min (201 ± 68 min).

There were nine complications experienced by the patients throughout the 3-month follow-up period, yielding a complication rate of 1.36%. These included two systemic complications, consisting of two cases of hypotension which occurred intraoperatively, and seven local complications [3 seromas reported at the first week (1 case) and fourth week (2 cases) of follow-ups; 3 cases of contact dermatitis that occurred during the first week postoperatively, and only 1 case of hemorrhage noticed at the fourth

Table 1 Sociodemographic characteristics of the study patients ($n = 609$)

Characteristic	N (%)
Gender	
Male	40 (6.5)
Female	569 (93.5)
Age (years)	
Mean $\pm$ SD	47.6 ± 9.3
Range	21–67
Number of body regions per patient	
1	563 (92.4)
2	42 (6.9)
3	3 (0.5)
4	1 (0.2)
Weight (kg)	
Mean $\pm$ SD	75.2 ± 15.2
Range	48–130
BMI (kg/m^2)	
Mean $\pm$ SD	27.8 ± 4.9
Range	19.3–47.7

BMI body mass index, SD standard deviation

week follow-up]. No death or any other SAEs were reported. More detailed information regarding the occurrence of complications per body region of liposuction is given in Table 2. Most complications from UAL were reported after operations on the abdomen (33.3% of total complications) and lower extremities (44.4% of total complications) and no complications were seen after the liposuction of the breast and back region (lower and upper parts).

Table 3 gives the type and number of complications with respect to the time they occurred. All of the systemic complications occurred during the operation and were resolved with proper volume replacement therapy. Local complications tended to occur early after surgery (most during the first 4 weeks postoperatively). No systemic complications or local complications were observed or reported at the 3-month routine follow-up. Using the Poisson regression model, no association was observed between the presence of complications and any other variables (Table 4).

Discussion

Following our retrospective evaluation, the complication rate of UAL among our patients was 1.36%. There were two systemic complications (2 cases of hypotension) and seven local complications (3 seromas, 3 cases of contact dermatitis, and 1 case of hemorrhage) in more than 600

Table 2 Number of patients experiencing a complication per liposuction body region^a

Body region	Number of operations (%)	Number of complications (%)	Complications
Abdomen (including flanks)	277 (42)	3 (0.45)	Seroma = 2 Hemorrhage = 1
Lower extremities (thighs and legs)	274 (41.5)	4 (0.60)	Seroma = 1 Contact dermatitis = 2 Hypotension = 1
Buttocks	54 (8.2)	1 (0.15)	Hypotension = 1
Upper extremities	23 (3.5)	1 (0.15)	Contact dermatitis = 1
Back (lower and upper)	19 (2.8)	0 (0)	–
Breast	13 (2)	0 (0)	–
Total	660	9 (1.35)	Seroma = 3 Contact dermatitis = 3 Hypotension = 2 Hemorrhage = 1

^a Percentages are given as the total liposuction body regions

Table 3 Timing, type, and number of different complications over 3-month follow-up

Timing	Complication type (<i>n</i> = 9)	Number (%)
Intraoperatively	Hypotension (2)	2 (22)
Within 1 week postoperatively	Seroma (2); contact dermatitis (3)	5 (56)
Within 4 weeks postoperatively	Seroma (1); hemorrhage (1)	2 (22)
Within 12 weeks postoperatively	–	0 (0)

Table 4 The association between number of complications and body region, age, gender, and BMI as predictors

Predictors	Coefficient	<i>p</i> value	95% confidence interval	
Upper extremities	−4.882988	0.999	−54525.08	54515.32
Abdomen	13.53159	0.999	−24893.58	24920.64
Buttocks	−4.594351	0.999	−59755.94	59746.75
Back	−20.85122	0.999	−161855.8	161814.1
Breast	12.97566	0.999	−50762.95	50788.9
Lower extremities	−17.70222	0.999	−24689.56	24654.15
Age	−0.0473006	0.452	−0.1706531	0.0760519
Gender	16.90223	0.998	−12436.67	12470.47
BMI	0.0689853	0.635	−0.2160913	0.354062

BMI body mass index

p < 0.05 was considered significant

operations. No death or any other SAEs were reported. There was no association between complication rate and different predictors of complication.

In the recent past numerous studies have been performed to evaluate the safety of different liposuction techniques and these studies have reported some controversial results; however, almost all have concluded that liposuction performed under general anesthesia (traditional or SAL) is associated with considerable risks including death [16, 19, 20]. They reported as many as 2.6–19.1 mortalities per

100,000 liposuctions in some surveys [20, 21], while other methods in which local tumescent anesthesia is used (TL and UAL), despite some controversies [15], caused no death [1, 5].

In response to widespread media attention to the adverse outcomes after liposuction, Hanke et al. [5] conducted the first national survey in 1994 that yielded data on the safety of local TL in 15,336 patients. They reported no SAEs. There were, however, some mild systemic complications such as febrile reaction, cardiac arrhythmia requiring treatment, and tachycardia. Another study performed by Housman et al. [1] in 2002 to evaluate the SAEs of TL in 66,570 liposuction procedures documented a SAE rate of 0.68 per 1000 cases with no reported deaths. These serious adverse events included massive infection (defined as local or systemic infection requiring intravenous antibiotics); abdominal wall, thoracic wall, or viscus perforation; hypotension; shock; and hemorrhage. Other reported serious adverse events were pulmonary embolus, fat embolus, and anesthesia/sedation medication reaction or toxicity. The rate of local complications was not assessed.

Whether a new technology is considered a major advance for a particular surgical treatment is often measured by the extent to which it increases efficacy and safety. Ultrasound-assisted liposuction (UAL) was a new technology that gained popularity in the early 1990s [6]. Experience with this new technique in Europe and the U.S.

has generally been positive, but based on some in vitro studies [22–29], reservations exist about the effects of ultrasonic energy interaction with living tissue, including alteration in cell division rates, acceleration in apoptosis, and production of DNA strand breaks and point mutations that theoretically may cause the spread of in situ cancers. However, it would appear to be difficult to extrapolate the results of these in vitro studies to make realistic estimates about the mutagenic risks of ultrasound in vivo [30].

On the other hand, initial reports also raised concerns about high seroma rates, longer operating times, skin necrosis and burns [31–33], fat necrosis and fibrosis, hyperpigmentation, and sensory alteration [13]. Recent studies conclude that the technical aspects of UAL can be used safely [7] and with no perioperative and postoperative complications [34] when certain fundamental principles are observed [35]: (1) appropriate patient selection, (2) appropriate anatomical sites, (3) attention to operative technique, (4) careful selection of infiltrating solutions, (5) adequate fluid management, (6) good patient monitoring and documentation, and (7) postoperative compression garments.

In addition to the previously mentioned benefits of UAL over SAL, including less injury to nerves and blood vessels, less overall tissue trauma, minimized blood loss, smaller-diameter channels formed in adipose tissue, smooth tunnels created in adipose tissue, more even shaping of overlying skin surfaces, accurate positioning of probes, and spot-specific tissue removal [8], and the reported advantages of UAL over TL, such as less damage to the vascular and nervous structures, reduced bleeding, less bruising, swelling, and discomfort with more skin retraction at the postoperative stage, and less physical effort for the surgeon [9–12], it is important to have a more detailed comparison between the complications of these different liposuction procedures.

The overall complication rate in our study was 1.36% (9 of 660), which is similar to that of the 2004 study of Hanke et al. [36] using TL (14 of 688), and that of the 2003 study of Katz et al. [6] performed using power liposuction (PL) (3 of 207). In our prospective study, no deaths or SAEs were reported while a SAE rate of 0.68 per 1000 cases was reported in the national survey on liposuctions that used the tumescent technique [1]. Having a more precise comparison between UAL and TL reveals fewer types of local complications following UAL than TL and lower probability of SAEs but more reports of complications such as skin necrosis and burns which result from the heat of the ultrasound device. The relatively high seroma rates in our study may be related to the cannula size we used, which was larger than usual, and also because in a few cases we closed wide incision sites. UAL's complication rate seem to be significantly lower than the complication rates

associated with liposuction performed under general anesthesia, which was reported to be about 16–18.8% in different studies [16, 37, 38].

In agreement with other studies, we found that UAL performed using local tumescent anesthesia is truly a safe procedure with a very low complication rate. Moreover, there was no correlation between the incidence of complications with body region, age, gender, or BMI. The additional benefits of the UAL technique combined with fewer local complications and no SAEs, compared with other liposuction techniques (TL and SAL), suggest that it may become a more widely used modality in liposuction surgery.

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