Water-Assisted Liposuction for Body Contouring and Lipoharvesting : Safety and Efficacy in 41 Consecutive Patients

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Water-Assisted Liposuction for Body Contouring and Lipoharvesting: Safety and Efficacy in 41 Consecutive Patients

Gordon H. Sasaki, MD, FACS

Abstract

Background: Water-assisted liposuction (WAL) is a new technique for body contouring and fat harvesting that relies on a fan-shaped jet of tumescent solution to anesthetize fatty for liposuction and grafting. As with any new technology, safety and efficacy are paramount.
Objective: The author evaluates the technique and outcomes for small-to-moderate volume liposuction cases treated with WAL in an office setting.
Methods: Forty-one consecutive patients were treated with WAL (Body-Jet; Human Med, Eclipse Ltd., Dallas, Texas) in the author's private practice for mild-to-moderate body contouring. Patients were given local anesthesia (standardized tumescent solutions) during all three phases of the surgery. During the latter two phases, irrigation of tumescent solution was accompanied simultaneously by suction aspiration. Fat harvesting was accomplished by collecting and separating the aspirated adipose tissue in a sterile container, without need for washing or centrifugation. Fat grafting by microdroplet technique was performed within two hours of collection. Fat aliquots from five randomly-selected patients were assessed with a trypan blue dye exclusion test within one hour and again six to eight hours after collection.
Results: A total of 37 females and four males underwent WAL in this series; average body mass index (BMI) was 25.5. Among the 41 patients, 166 areas involving twelve anatomic sites were treated. Patients were divided into two groups based on the volume of treatment: Group 1 contained 19 patients with small-volume WAL and Group 2 had 22 cases of moderate-volume WAL. All patients experienced uneventful recovery periods with minimal side effects and no significant complications. Although large volumes of tumescent solution were required during the three phases of the technique, the total volume of infiltration almost equaled the final volume of aspiration. The average infiltration-to-aspiration ratio was 1.1 to 1.0 in all cases over both groups. On the other hand, the average infiltration-to-fat ratio was 2.8 to 1.0 in Group l and 2.4 to 1.0 in Group 2. Lidocaine dosage averaged 10.5mg/kg in Group 1 and 20.0mg/kg in Group 2. Patients were monitored for at least 24 hours without adverse signs or symptoms that required fluid resuscitation, blood transfusions, or interventional treatments for lidocaine side effects or toxicity. Twenty-three patients elected to save their fat for autologous fat grafting in nine anatomical sites with thirty-nine procedures. The augmented sites were clinically assessed between three and eight months postoperatively. Trypan blue dye exclusion testing indicated that about 90% of adipocytes expelled the dye after one hour of extraction, while an estimated 10% of cells per patient were observed to be free of dye six to eight hours after removal.
Conclusions: The amount of instilled tumescent fluid, lidocaine dosage, and aspiration volumes appeared to be safe, with minimal blood loss in small and moderate volume liposuction cases. The early experience with fat grafting was encouraging, but requires more sophisticated evaluation, longer follow-up, and a larger number of cases.

Keywords

lipoplasty, water-assisted lipoplasty, fat harvesting

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Water-assisted liposuction (WAL) may represent a new algorithm in the continuous evolution and development of liposuction techniques[1-5] and devices[6-12] to remove fat for contouring and harvesting purposes. WAL utilizes a dual-purpose cannula that emits pulsating, fan-shaped jets of tumescent solution, followed by simultaneous suctioning of the fatty tissue and the instilled fluid. A variable-force infusion pump drives the infiltration solution through a closed tubing system into a passageway within the application cannula. The fluid streams out from the cannula's nozzle tip at a 30° angle to loosen the fatty tissue. The washed-out fatty tissue is evacuated from surgical sites through a

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separate channel within the cannula, which is connected to an integrated suction unit. The application cannulae vary in diameter, arrangement, and sharpness of openings. The flow rate of the infiltrate, as well as the application of variable intensities of negative pressure, can be selected at different levels, depending on the purpose. A sterile container can be connected between the working cannula and the suction pump to collect the aspirate under reduced negative pressures. The fat is separated from the infranate for immediate usage without centrifugation.

WAL relies on two tumescent subcutaneous infiltration solutions. A higher concentration of lidocaine in the infiltration solution is employed during Phase 1 to provide longer-lasting local anesthesia and vasoconstriction. A solution with lower lidocaine concentration is instilled during Phase 2 (simultaneous infiltration and aspiration) and Phase 3 (drying or finishing) to reduce the pharmacological effects of lidocaine and the accompanying fluid load.

Progressive improvements in the application of tumescent solutions, methodologies and instruments, and criteria for patient selection remain critical for patient safety and efficacy with any type of liposuction procedure. This preliminary report investigates whether saline rinsing of fatty tissue results in safe fluid and lidocaine management, minimal blood loss, consistent lipo shaping with tissue accommodation, efficient fat harvesting, transfer and survival, and low complication rates with acceptable outcomes.

METHODS

WAL treatments are indicated for patients with moderate collections of adiposity and mild to moderate degrees of skin laxity, as well as for those who desire augmentation with their fat. Patient exclusion criteria for this study included pregnancy, uncontrolled diabetes mellitus, collagen disorders, cardiovascular diseases, and bleeding disorders. A total of 41 consecutive patients who presented to the author's private practice for body contouring were included in the study and treated with WAL—specifically, Body-Jet (Human Med, Eclipse Ltd., Dallas, Texas).

Standardized digital photography was obtained before surgery, along with data about each patient's weight, height, percentage body fat, and body mass index. Patients were marked in the standing and sitting positions (to localize zones of treatment), and the markings were confirmed by caliper measurements. Patients were offered preoperative oral medication for pain and sedation. An intravenous catheter was inserted for access before surgery and removed upon discharge.

Preinfiltration of Anesthetic Solution

All surgeries were performed in an office setting under local anesthesia with a standardized saline wetting solution consisting of lidocaine, epinephrine, and sodium bicarbonate. Low volumes of buffered 0.5% lidocaine containing 1:200,000 epinephrine (eight parts lidocaine, two parts 8.4% sodium bicarbonate) were injected above the fascial planes to completely anesthetize the sensory nerves. This maneuver was facilitated by grasping the tissues in a fold to separate the skin-fat layers from the underlying muscular-fascial layers. Smaller volumes of 0.5% ropivacaine, up to a maximum of 50 mL, were injected into sensitive areas over bones (costochondral rib margins, iliac crests, paraumbilicus) and along the borders of the anticipated suctioning areas for more prolonged periods of anesthesia.

Table 1. Standard Wetting Solutions

Phase 1	mL	Phases 2 and 3	mL
Normal saline	1000	Normal saline	1000
Lidocaine 1%	50 (500 mg)	Lidocaine 1%	25 (250 mg)
Epinephrine 1 mg/mL	1	Epinephrine 1 mg/mL	1
Sodium bicarbonate 8.4%	20	Sodium bicarbonate 8.4%	20

Phase 1: Infiltration of Tumescent Solutions

The tumescent solution utilized in Phases 1 through 3 contained identical ingredients, with the exception of the milligrams of lidocaine per liter of normal saline (Table 1). An infiltration cannula was positioned in the deep subcutaneous fat, after the skin-fat folds were grasped away from the underlying musculofascial structures. The Body-Jet system's setting of "1" was selected, which sprayed the prewarmed wetting solution about 2.5 cm in front of the nozzle at the lowest rate, 90 mL per minute. The cannula was moved slowly back and forth in the same tract, yielding a path of hydrodissection as the spray was directed downward on the first pass (toward the fascia) and upward (toward the fat) in a twisting motion during the second pass. Corridors of hydrodissection were generated in a fan-shape pattern, covering the entire zone to be suctioned. The low infiltration rate provided a sufficient level of anesthesia, efficient rinsing of fat lobules, and minimal tissue bogginess in preparation for suctioning.

Phase 2: Simultaneous Irrigation and Aspiration

During Phase 2, a low infiltration setting was preferred over higher settings to allow for more efficient aspiration of minimally turgid tissues. A slow, deliberate "to and fro" motion of the cannula was the most economical maneuver for fatty tissue removal through the predetermined fan-shaped pathways once the skin-fat folds were distracted from the underlying muscle fascia. When denser fibrotic tissue was encountered, a cannula was selected that was larger or had a sharper orifice. Also, a higher infiltration

Table 2. Sites Treated by Water-Assisted Liposuction in 41 Patients

Anatomic Site	Patients, n	Anatomic Site	Patients, n	Anatomic Site	Patients, n
Brachia	16	Breasts	2	Gynecomastia	2
Axillae	10	Abdomen	33	Neck	1
Brassiere rolls	18	Saddlebags	16		
Hip rolls	32	Banana rolls	6		
Lumbar rolls	16	Thighs	14		

rate was found to be possibly more efficient for fat removal, at 750 mm Hg of negative suctioning. The clinical endpoint of fat elimination was determined by a paucity of fatty tissue withdrawn in the tubing, a reduction in the diameter of the grasped fat fold, and the presence of minimal resistance during repetitive passages of the cannula.

Phase 3: Drying

During Phase 3, a cannula with fenestrations on its undersurface was applied to remove remnants of fat beneath the dermis, with a low rate of tumescent solution infiltration and a high level of negative suctioning. During this phase, the cannula was threaded slowly back and forth, with openings directed away from the dermis to minimize skin irregularities. "Feathering" of tissues was performed by deactivating the irrigating and suctioning functions to eliminate any remaining irregularities.

Postoperative Management

A 0.25-inch (0.635-cm) Penrose drain was inserted into one of the dependent openings to facilitate drainage over 24 hours. Other openings were loosely closed with a single suture and dressed with foam sponges. Patients were instructed to wear a compression garment around the area for at least two to three weeks, after which most were able to resume their normal activities.

RESULTS

Beginning in May 2009, 41 consecutive patients (37 women, four men) received WAL treatment in the author's private practice. Participants had a mean age of 47.6 years (range, 25 to 70 years), a mean height of 163.4 cm (range, 149 to 188 cm), a mean weight of 70.6 kg (range, 51.7 to 112.0 kg), a mean body fat of 30.4% (range, 17.5% to 39.4%), and mean body mass index of 25.5 (range, 21.7 to 30.0). Among the 41 patients, 166 liposuction procedures were performed in 12 anatomical sites. Twenty-two patients (53.7%) elected to undergo liposuction more than one site at the same session (average, 3.4 sites; range, two to six sites).

The most common combination was treatment to the hip rolls and abdomen (Table 2). The patients were preoperatively divided into two groups based on the estimated volume of liposuction required (dictated by whether they elected to have multiple-site liposuction during the same procedure).

Group 1

Nineteen patients in the series had smaller volumes of estimated fat to be aspirated. For these patients, the total volume of infiltration solution, total lidocaine dose, and total component volumes of aspiration (infiltration fluid and fat) were recorded from each site after liposuction (Table 3). The average volume of infiltration solution was measured at 2370 mL (range, 450 to 4375 mL), while the average volume of aspiration was calculated to be about 2339 mL (range, 340 to 4150 mL). The average infiltration:aspiration ratio was determined to be 1.1:1.0. The average infiltration:fat ratio was calculated to be 2.8:1.0 (ie, for every 1000 mL of fat removed, 2800 mL of infiltrate was required). The average fat percentage of the total aspirate was 36.5% (range, 14.8% to 73.5%). None of the patients received additional fluid replacement; each patient was hemodynamically stable throughout the entire procedure and in the immediate postoperative recovery period. Lipocrits of less than 1.0% were estimated from millimeters of red blood cells and millimeters of fluid not containing red blood cells, from aspirates measured within centrifuged capillary tubes taken from final aspirates in 15 randomly selected patients.

Group 2

The 22 patients undergoing multiple-site liposuction were estimated to have larger volumes of fat removed and were therefore included in Group 2. The cumulative total volumes of infiltration solution, total lidocaine dose, and total volumes of aspiration (infiltration solution, fat, and blood) were calculated in a similar fashion to the data for Group 1 (Table 4). In this group, the average volume of tumescent infiltration was 3982 mL (range, 650 to 6000 mL), while the average volume of aspiration was 3502 mL (range, 705 to 6310 mL). The average infiltration:aspiration ratio was calculated to be 1.1:1.0. The average infiltration:fat ratio was determined to be 2.4:1.0 (ie, for every 1000 mL of fat removed, 2400 mL of wetting infiltration was provided). The average fat percentage of the total aspirate was 47.3% (range, 26.8% to 79.5%). Even in these larger procedures, patients were hemodynamically stable throughout the procedures and required no additional fluid resuscitation. Lipocrits of less than 1.0% were estimated with the same method described in Group 1, from final aspirates centrifuged within capillary tubes from 15 randomly selected patients.

Fat Augmentation

Twenty-three patients had fat harvested for augmentation. This portion of the study was performed in nine anatomical sites over 39 procedures (Table 5). Abdominal fatty tissue

Table 3. Total Lidocaine Dosage, Infiltration Volumes, Aspiration Volumes (Fluid/Fat), and Infiltration:Aspiration (I:A) and Infiltration:Fat (I:F) Ratios

No.	Site	Weight, kg	Total Lidocaine, mg	Lidocaine Dosage, mg/kg	Total Wetting Solution, mL	Total Aspirate, mL	I:A Ratio	Total Fat, mL	I:F Ratio
1	Brachia	63	212	3.4	700	675	1.0:1.0	350	2.0:1.0
2	Brachia	58	250	4.3	800	890	0.9:1.0	300	2.6:1.0
3	Hip rolls	27	173	6.4	450	340	1.3:1.0	250	1.8:1.0
4	Posterior thighs	52	712	13.7	1725	1600	1.1:1.0	980	1.8:1.0
5	Abdomen	98	975	9.9	3050	3025	1.0:1.0	1815	1.7:1.0
6	Abdomen	58	1125	19.3	3500	3200	1.1:1.0	475	2.4:1.0
7	Abdomen	56	720	12.8	2150	2025	1.1:1.0	1215	1.8:1.0
8	Abdomen	68	1326	19.5	4375	4150	1.1:1.0	850	5.1:1.0
9	Abdomen	54	500	9.2	2400	2050	1.2:1.0	1200	2.0:1.0
10	Abdomen	62	1094	17.6	3500	3000	1.2:1.0	975	3.6:1.0
11	Abdomen	67	625	9.3	2550	2000	1.3:1.0	975	2.6:1.0
12	Abdomen	79	1020	12.9	2700	2200	1.2:1.0	800	3.4:1.0
13	Abdomen	83	750	9.0	3200	2800	1.1:1.0	1100	2.9:1.0
14	Abdomen	62	933	15.0	2800	2930	1.0:1.0	880	3.2:1.0
15	Abdomen	57	650	11.4	2500	2030	1.2:1.0	1015	2.5:1.0
16	Abdomen	74	750	10.1	3000	3550	0.8:1.0	955	3.1:1.0
17	Abdomen	66	452	6.8	2500	2425	1.0:1.0	730	3.4:1.0
18	Abdomen	88	662	7.5	2625	3000	0.9:1.0	1200	2.2:1.0
19	Neck	104	150	1.4	500	425	1.2:1.0	150	3.3:1.0
	Averages	**67**	**688**	**10.5**	**2370**	**2339**	**1.1:1.0**	**853**	**2.8:1.0**

was harvested by repetitive spraying of tumescent solution. Fatty tissue was removed under reduced negative pressure at 450 mm Hg to 500 mm Hg, collected and separated from the infranate at room temperature in the sterile container without washing or centrifugation, and immediately withdrawn under low negative pressures into capped 1-mL or 10-mL injection syringes.

Within two hours of harvesting, fat grafting by microdroplet technique was initiated in the majority of patients. Depending on the structural demands of the recipient site, a blunt-tipped micrografting cannula (attached to the filled syringe) was applied to deposit the fat droplets in a fanlike pattern at varying levels in the supraperiosteal, submuscular, and/or subcutaneous planes. Injection occurred during the withdrawal phase so that less pressure was applied, reducing potential damage to the adipocytes. Injection was completed when a satisfactory slight overcorrection was achieved. Further redistribution and smoothing of the infiltrated fat were obtained by rolling the syringe barrel over the grafted site. Selected clinical results between six and eight months postoperatively are shown in Figures 1 to 3.

Histological Assessment

Fat aliquots from five randomly selected patients were incubated with trypan blue vital dye to determine the percentage of adipocytes that absorbed and expulsed the dye within one hour and six to eight hours after extraction (Figure 4). Microscopic assessment after trypan blue dye exclusion test methodology[13] demonstrated that about 90% of adipocytes absorbed and released the dye one hour after aspiration, indicating cell viability. At six to eight hours, less than 10% of examined adipocytes excluded the vital dye, suggesting loss of cell functionality.

Outcomes and Complications

In general, patients reported being satisfied with the changes in their bodies after WAL liposuction at the six-month postoperative visit (Figures 5-7). Each patient was asked to record his or her impression of the degree of intraoperative and postoperative pain on a visual analog scale from 0 to 10. Patient responses indicated an average

Table 4. Total Lidocaine Dosage, Infiltration Volumes, Aspiration Volumes (Fluid/Fat), and Infiltration:Aspiration (I:A) and Infiltration:Fat (I:F) Ratios

No.	Site	Weight, kg	Total Lidocaine mg	Lidocaine Dosage, mg/kg	Total Wetting Solution, mL	Total Aspirate, mL	I:A Ratio	Total Fat, mL	I:F Ratio
1	Abdomen, hips, gynecomastia	82	1767	21.5	5300	6310	0.9:1.0	1700	3.1:1.0
2	Abdomen, hips, thighs	52	1500	28.75	3500	3000	1.2:1.0	1670	2.1:1.0
3	Abdomen, inner thighs	57	1250	21.9	2500	2100	0.9:1.0	700	3.6:1.0
4	Axillary, brassiere, lumbar rolls, hips	53	1500	28.3	6000	5500	1.2:1.0	2700	2.2:1.0
5	Abdomen, banana rolls	54	1450	26.8	2600	2200	1.2:1.0	1750	1.5:1.0
6	Abdomen, arms, lumbar, saddlebags, thighs	52	983	18.9	5500	4550	1.4:1.0	1900	2.9:1.0
7	Axillary, brassiere rolls, hips, abdomen	64	1684	26.3	5800	4800	1.2:1.0	2500	2.3:1.0
8	Abdomen, brassiere, hips, lumbar rolls, thighs	67	1833	27.489	5500	4500	1.2:1.0	2200	2.5:1.0
9	Abdomen, hips	112	2000	17.8	4700	3620	1.3:1.0	1250	3.8:1.0
10	Thighs, hips, banana rolls	58	1150	19.8	3450	2800	1.2:1.0	750	4.6:1.0
11	Abdomen, hips, banana rolls	53	833	15.7	2500	2185	1.1:1.0	1050	2.4:1.0
12	Abdomen, brassiere, lumbar, hips, thighs	48	926	19.3	3000	2600	1.2:1.0	1500	2.0:1.0
13	Abdomen, arms, breast, axillary rolls	67	1198	17.9	3200	3310	1.0:1.0	1700	1.9:1.0
14	Abdomen, hips	67	1860	27.8	4650	3700	1.2:1.0	2000	2.3:1.0
15	Abdomen, arms, hips	72	1255	17.4	4350	3925	1.1:1.0	1750	2.5:1.0
16	Axillary, brassiere, lumbar rolls	62	569	9.1	2500	2500	1.0:1.0	850	2.9:1.0
17	Axillary, lumbar rolls, hips, abdomen	64	1201	18.8	4000	3780	1.0:1.0	2000	2.0:1.0
18	Brassiere, lumbar rolls, hips, abdomen, saddlebags	70	1767	5.2	5300	4500	1.2:1.0	2500	2.1:1.0
19	Abdomen, arms	83	1133	13.7	3050	2650	1.2:1.0	2000	1.5:1.0
20	Abdomen, brassiere, lumbar, hip rolls, brachii	54	1275	23.6	4000	3050	1.3:1.0	1725	2.3:1.0
21	Abdomen, brassiere rolls	59	212	3.6	650	705	0.9:1.0	250	2.6:1.0
22	Abdomen, lumbar hip rolls	98	1700	17.3	5550	4750	1.2:1.0	2000	2.8:1.0
	Averages	66	1320	20.0	3982	3502	1.1:1.0	1656	2.4:1.0

Table 5. Sites and Average Volumes of Fat Injections in 23 Patients

Anatomic Site	Patients, n	mL/Side	Anatomic Site	Patients, n	mL/Side
Midface	6	5-6	Calf	1	75-100
Buttock	4	200-500	Knee	1	25
Hand	3	5-8	Ankle	1	25
Breast	1	100-125	Depressions	5	2.5-30 mL
Thigh	1	30			

intraoperative pain level of 1 to 2 and a postoperative pain level of 1 to 3 on the second or third day after surgery. Almost all patients were able to resume their presurgical routines by the seventh postoperative day, depending on the extent and number of treatment sites.

During surgery and in the 24 hours after surgery, none of the 41 patients demonstrated hemodynamic instability due to larger infiltration and aspiration volumes. Patients did not recall or exhibit side effects such as prolonged lightheadedness, euphoria, digital or circumoral paresthesias, tremors, blurred vision, tinnitus, or severe nausea and vomiting. Total blood loss was negligible, as determined by the lipocrit measurements in 30 patients.

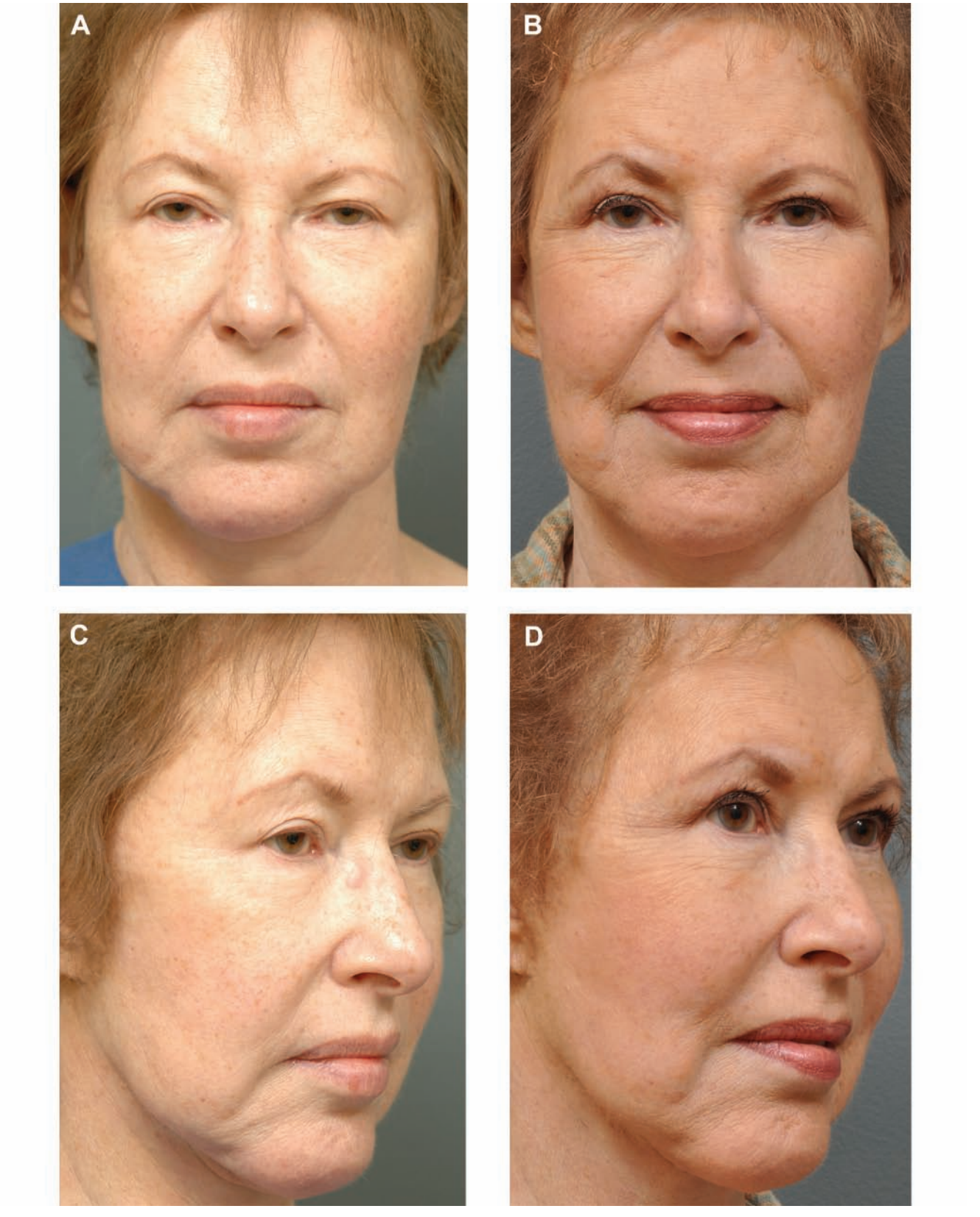

Figure 1. (A, C) This 65-year-old woman demonstrated loss of fullness to the anterior midface, revealing palpebromalar and nasojugal grooves. (B, D) Eight months after 5 to 6 mL of fat grafting by microdroplet technique within compartments in the supraperiosteal planes of each anterior midface, extending through the lid-cheek junction, tear-trough, and malar eminence, down to the nasolabial fold. The fat was aspirated with the water-assisted liposuction technique.

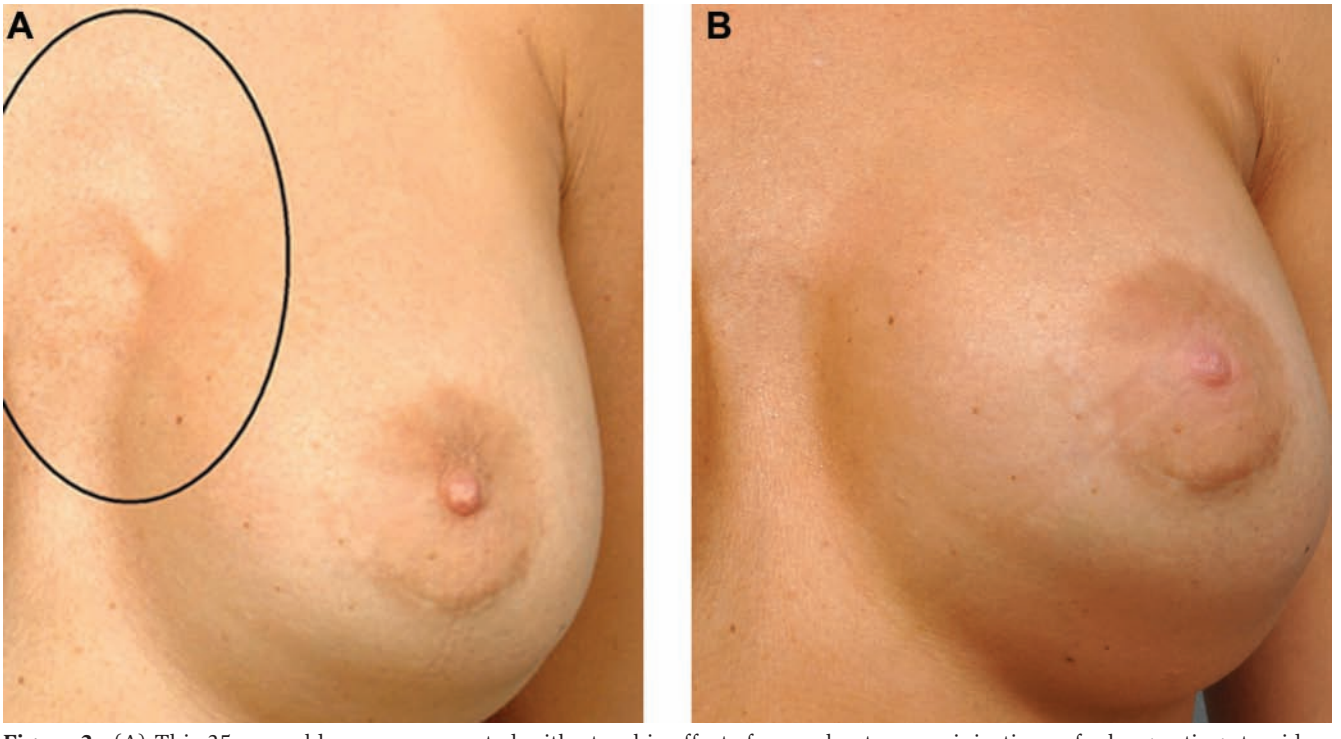

Figure 2. (A) This 25-year-old woman presented with atrophic effects from subcutaneous injections of a long-acting steroid deposited around the periphery of a contracting capsule surrounding a subglandular positioned breast implant. (B) Six months after 33 mL of fat was layered in a threadlike fashion in the subcutaneous spaces over the sternum and ribs. The fat was aspirated with the water-assisted liposuction technique.

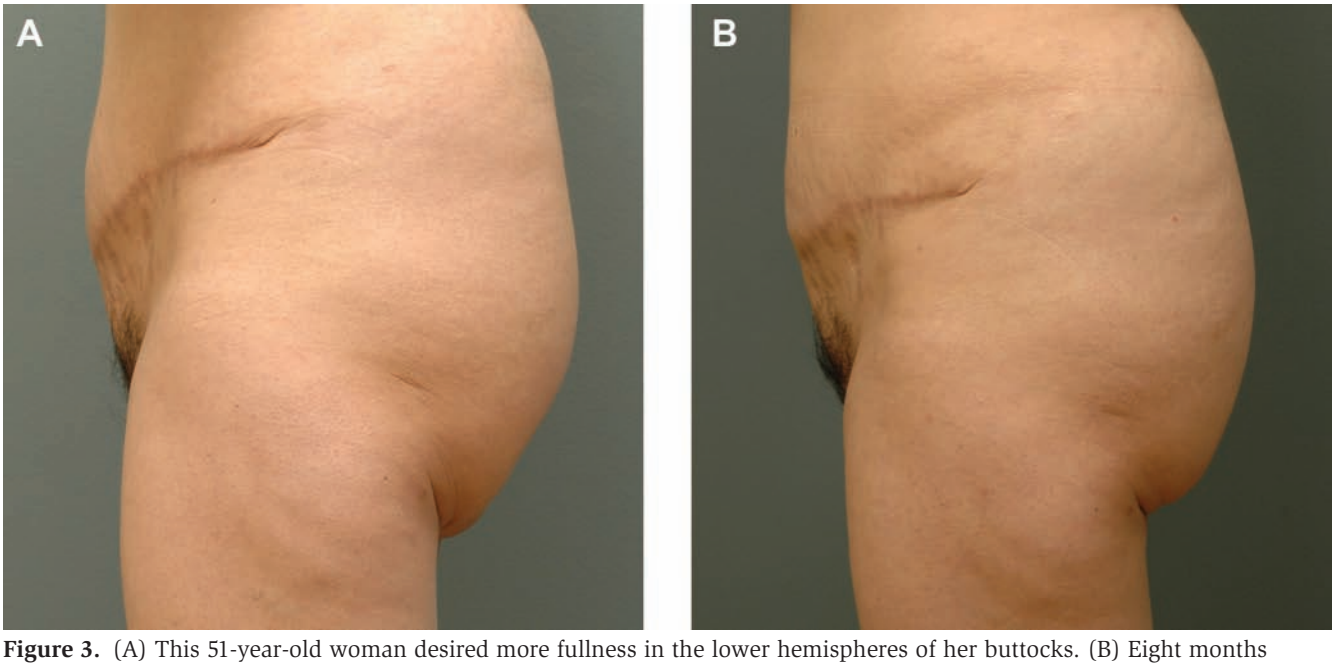

Figure 3. (A) This 51-year-old woman desired more fullness in the lower hemispheres of her buttocks. (B) Eight months after autologous augmentation in which about 450 to 500 mL of fat was layered by microdroplet technique in the muscular level for volume and in the deep subcutaneous tissue for projection. The fat was aspirated with the water-assisted liposuction technique.

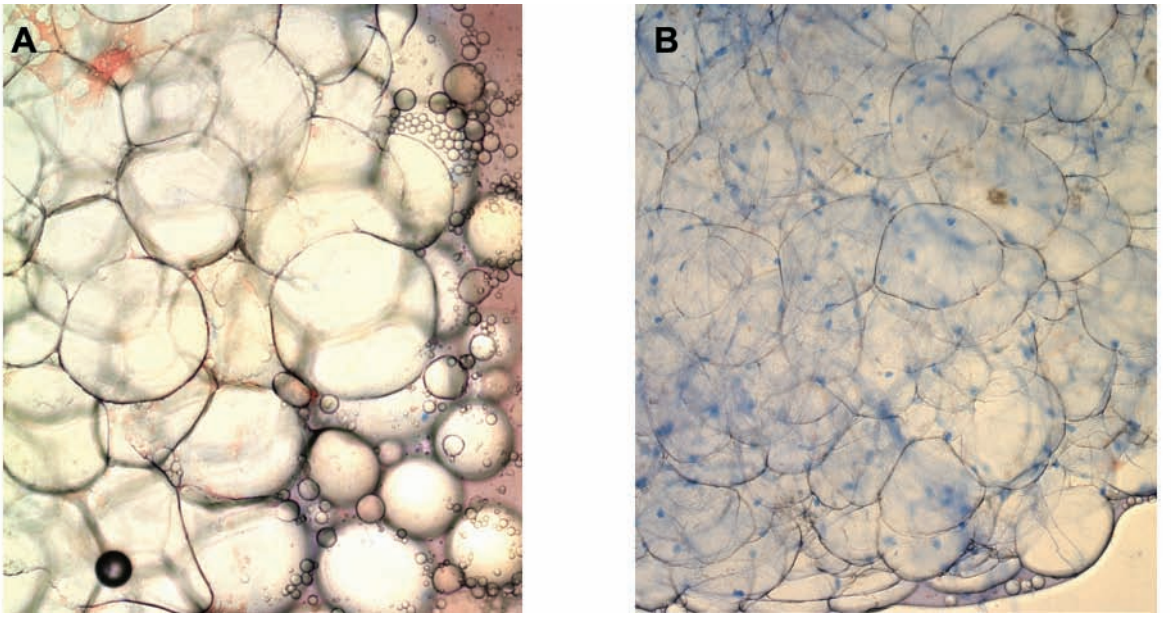

Figure 4. (A) This histocytological study demonstrated that 90% of adipocytes from Patient 10 absorbed and expelled trypan blue dye within one hour of exposure, indicating viability of cells. (B) The same aliquot of cells from Patient 10 was incubated at room temperature for six to eight hours. Retention of the blue dye indicated a loss of cell function.

About 3% of patients developed nodularity within six weeks after surgery. Irregularities were successfully managed by a series of external ultrasound treatments and resolved by three months. There was no incidence of infection, seroma formation, hematoma, blistering, dyschromia, permanent nerve injury, or thrombosis in the lower extremities. In lipoinjected sites, no clinical papules, nodules, or liquefied fat collections were detected. No patient from this series requested revision surgery for insufficient fat removal, asymmetries, or unacceptable irregularities.

DISCUSSION

Liposuction remains one of the most commonly-performed aesthetic surgical procedures[14] and is performed safely and effectively with a number of devices and techniques. Nevertheless, there is debate regarding the clinical merits of delivering controlled thermal injury to collagen fibers by ultrasound,[15] laser,[16] and radiofrequency sources to enhance tissue-tightening results through innovative energized devices versus the well-documented results observed after traditional liposuction.

WAL represents the most recent technical advance, introduced in the United States less than two years ago. The WAL system (in this case, Body-Jet) impacts fatty tissue by directing a spray of tumescent solution to dislodge the fat lobules and "preserve the integrity of blood/lymphatic vessels, nerves, and septae retinaculi cutis."[17,18] Whenever a new device for liposuction is introduced, there exists not only the necessity for generational improvements, but also advances in treatment algorithms to maximize profiles for safety and efficacy. In addition, the most current device must demonstrate at least equal or superior results to existing successful technologies.[8] While this report does not compare WAL to other (more established) techniques, it does attempt to address specific issues pertinent to the safety and efficacy profiles of this device for small-to-moderate-volume volume liposuction.

To that end, the first parameter for analysis involved the total amount and composition of the infiltration solution instilled into the subcutaneous fat during Phase 1 and in combination with suctioning during Phases 2 and 3, to classify it as a superwet[19-21] or tumescent[22,23] technique. One of the distinguishing features that separates these two established techniques is the ratio of total volume of subcutaneous infiltration to final volume of fat aspiration[24]: superwet, 1.0:1.5:1.0; tumescent, 2.0:3.0:1.0. Because of the difficulty in preoperatively identifying the total volume of aspirated fat, clinicians have designated as their final aspiration volume a value that represents the combined volumes of retrieved fat, infiltration fluid, and blood (an infiltrate:aspirate ratio). In this study, the calculated infiltrate:aspirate ratios suggested that the WAL technique could be defined as a superwet procedure (Group 1: 2370 mL infiltration to 2339 mL aspiration = 1.0:1.0; Group 2: 3982 mL infiltration to 3502 mL aspiration = 1.0:1.0). However, according to the infiltrate:fat ratios, WAL could be characterized as a tumescent technique (Group 1: 2370 mL infiltration to 853 mL fat aspiration = 2.8:1.0; Group 2: 3982 mL infiltration to 1656 mL fat aspiration = 2.4:1.0). The relative proportion of these derived ratios for this study's small-to-moderate-volume volume liposuction may not be the same in large-volume liposuction cases with more than 3000 mL of fat removal. Further

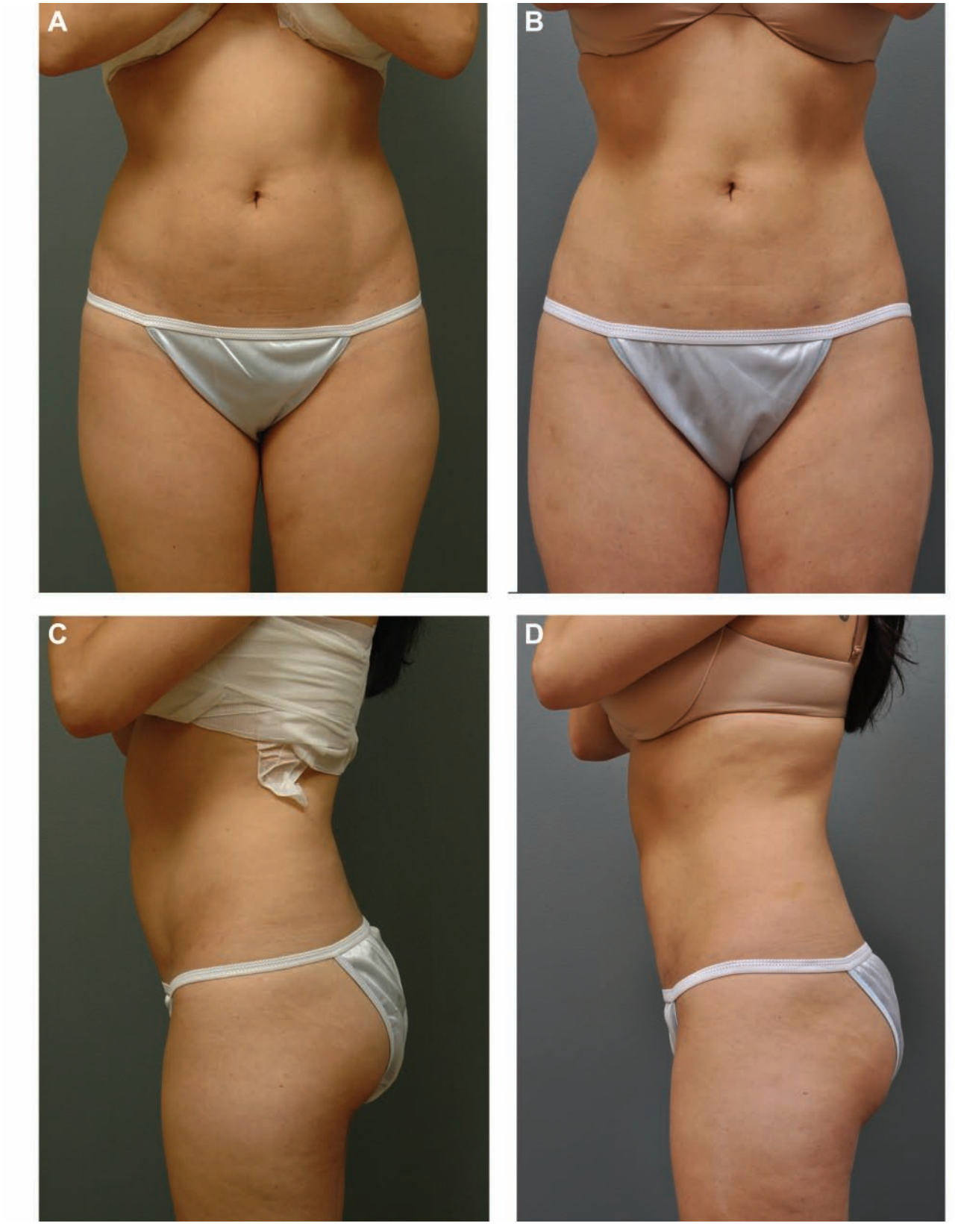

Figure 5. (A, C) This 25-year-old nulliparous woman (Patient 2, Group 2) requested body contouring to her upper and lower abdomen, hips, and lateral thighs. (B, D) Six months after water-assisted liposuction, the patient shows improved sculpting of the anterior abdomen, reduction of the adjacent hip rolls, and contouring of the lateral hips. The total volume of wetting solution infiltrated was about 3500 mL; the total aspiration volume was recorded as 3000 mL, of which 1670 mL was fat. The lipocrit was estimated to be about 0.9%.

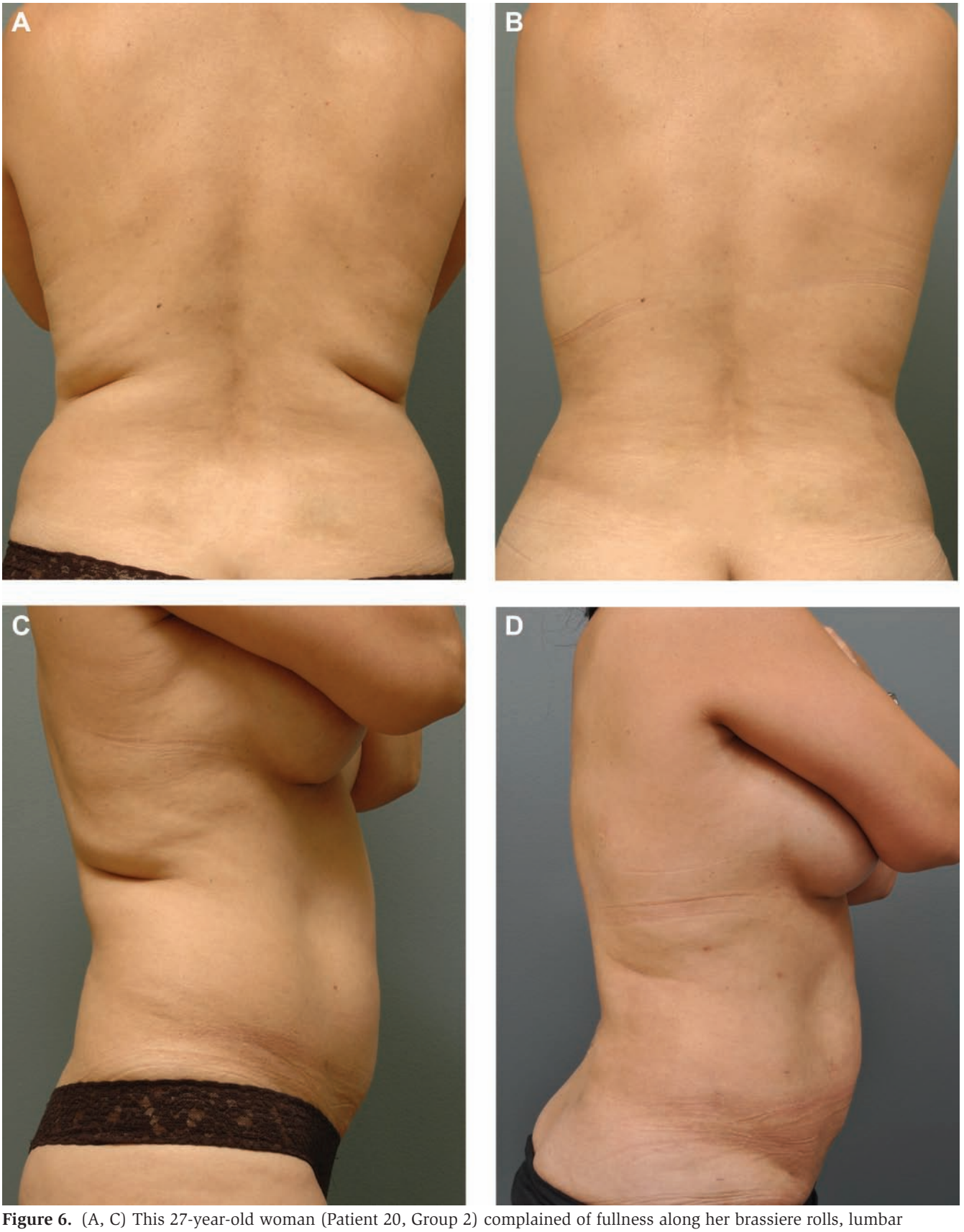

Figure 6. (A, C) This 27-year-old woman (Patient 20, Group 2) complained of fullness along her brassiere rolls, lumbar rolls, and hips. (B, D) Seven months after water-assisted liposuction, the patient shows improved sculpting of the back rolls and hips. The total volume of wetting solution infiltrated was about 3500 mL; the total aspiration volume was estimated to be about 2700 mL, of which 1300 mL was fat. The lipocrit was estimated to be about 0.8%. The patient's infiltration and aspiration volumes to her brachii were not included in the data.

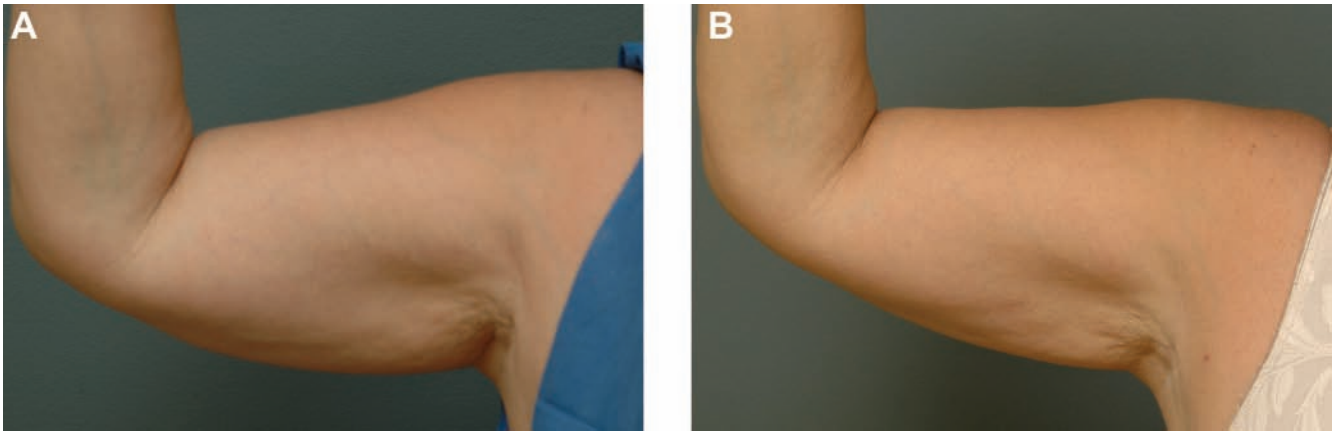

Figure 7. (A) This 52-year-old woman (Patient 2, Group 1) desired reduced fullness under her upper arms. She exhibited a moderate degree of skin laxity. (B) Six months after water-assisted liposuction, the patient shows reduction of fat and accommodation of skin to the surgically reduced contour. The total wetting solution infiltrated was 800 mL; the total aspiration volume was recorded at 890 mL, of which 300 mL was fat. The estimated lipocrit was recorded as 0.8%.

experience with a larger number of cases is required to more accurately define safe infiltrate:aspirate volumes, which would limit excessive drug and fluid exposures with this technique.

A second important parameter for analysis was the hemodynamic issue of required fluid resuscitation or blood transfusions when larger volumes of tumescent infiltration and aspiration were encountered during treatment. Preoperatively, patients in this series were instructed to hydrate themselves with six to eight glasses of a balanced electrolyte drink the morning of surgery. Although the total volume of infiltration slightly exceeded the total volume of aspiration, the present study did not focus on the dynamic fluid shifts within the body's compartments as a consequence of surgery. Even so, none of our patients experienced any significant hemodynamic fluid shifts or losses that resulted in detrimental changes to their vital signs (blood pressure, pulse, pulse oximetry, and urine output) during surgery and in the postoperative 24-hour recovery period. Furthermore, none of the patients received parenteral fluid replacement after fat removal of between 150 and 2700 mL. This limited clinical experience suggests enhanced safety in small-to-moderate-volume liposuction cases, but the evidence is not conclusive.

The total amount of blood loss after WAL liposuction was calculated from the estimated lipocrit (expressed as the milliliters of blood present in each milliliter of aspirate, multiplied by the total millimeters of aspirate) and it was found to be negligible in small- and larger-volume cases. Other experienced investigators[19,22,25-27] have reported that superwet or tumescent techniques are accompanied by hemodynamic stability and reduced need for blood transfusions. In spite of the conclusions drawn from these excellent studies, there are still no prospective randomized studies that define the optimal volumes of infiltrate or epinephrine needed to compensate for unsafe fluid shifts, blood losses, and large aspiration volumes. The surgeon should always be prepared to replace volume for patients who require large amounts of fat aspiration (ie, more than 3000 mL), based on clinical judgment and findings.

This study also examined the large amount of lidocaine infused into the subcutaneous tissue with the WAL technique during smaller-volume cases (Group 1 = 10.5 mg/kg) and larger-volume cases (Group 2 = 20.0 mg/kg). Although the observed lidocaine dosages in these patients were 1.7 to 2.9 times higher than those recommended as safe in the *Physicians' Desk Reference*[28] (7 mg/kg), they were considerably lower than levels of 30 to 70 mg/kg observed in other reports with tumescent techniques.[29-31] When plasma lidocaine levels were measured after infiltration of tumescent solution within the subcutaneous tissue in these studies, peak plasma levels of lidocaine occurred at six to 14 hours and were significantly below the safe limit of 5 µ/mL.[25,29,31,32] These studies found that higher-than-recommended dosages of lidocaine appeared to be safe when the drug was placed in the subcutaneous space, which did not facilitate rapid and toxic elevations of serum levels. As previously mentioned, patients in this study did not demonstrate any direct clinical signs or symptoms of lidocaine side effects or toxicity. Nevertheless, when non-recommended doses of lidocaine are administered, careful monitoring of patients beyond 24 hours will be required, especially in cases with large-volume fat removal and local tumescent anesthesia.

WAL potentially offers a benefit in terms of autologous fat transplantation; as such, that parameter was analyzed in 23 study patients who elected to undergo the additional procedure. Although the fat-harvesting and fat-processing phases of WAL were designed to obtain adipocytes before application, there have been no evidence-based medicine Level 1 or 2 articles[33] (high-quality, multicentered, randomized controlled trials) with this technique for fat harvesting, processing, transfer, and filling. While previous techniques[34-38] demonstrated no consensus in which fat-grafting methods resulted in definitive evidence of fat survival and retention, WAL shares common elements with the existing options. The observed retention volumes in these study patients during three- to eight-month follow-up represented only an interval estimate based on the author's opinion and not on an

evidence-based assessment. Since recent publications[39-42] reported a resorption rate of 20% to 90% after a year, a larger number of cases—with longer postoperative evaluations (up to two years) and with computed tomography scans or magnetic resonance imaging—may be required to provide an objective and quantitative measurement of graft take.

Despite these lingering questions, patients in this study were satisfied with their outcomes. They experienced minimal postoperative sequelae and were pleased with their postoperative appearance and contour. Since localized heat was not a part of the WAL technique, the degree of skin accommodation suggests other mechanisms for the beneficial skin retraction observed with patients with moderately loose skin. Additional, more sophisticated WAL studies will be required to verify the promising results.

CONCLUSIONS

On the basis of limited clinical experience, preliminary data suggest that WAL represents a positive addition to the array of currently available liposuction devices. It offers surgeons the opportunity to impact fatty tissue with a pulsating stream of tumescent solution and simultaneous removal of aspirate under local anesthesia in an office-based procedure. Patients in this series were satisfied with their outcomes, resumed normal activities usually within one to two weeks, and did not request any revision surgeries. The amount of blood loss was negligible, with lipocrits estimated at less than 1.0%. A significant improvement in fat graft survival was not assessed because of the limited number of patients, short follow-up period, and subjective evaluation methods. Further experience will be required to validate these observations.

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