Superwet Anesthesia Redefines Large-Volume Liposuction

Alan Matarasso, MD

Superwet anesthesia is a method of regional anesthesia for liposuction surgery that uses an evenly distributed, rapidly infused solution under pressure, until tissue blanching and moderate tension are achieved, in a ratio of 0.5 to 1.5 ml per milliliter of injectate to lipoaspirate. It is accompanied by systemic anesthesia and supplemented with intravenous hydration. The efficacy of superwet formulation for regional anesthesia was evaluated in a consecutive series of 20 patients who underwent large-volume (>1500 ml) liposuction. The average volume of injectate was 2285 ml and fat aspirate was 2437.5 ml. The average fluid volume fractionated from the aspirate infranatant was 507.5 ml, and the amount of injectate absorbed was 1775.5 ml. The mean "pure fat" fractionation was 1930 ml. Approximately 21% to 22% of injected fluid is not absorbed, so the ratio of fat removed to fluid absorbed by hypodermoclysis is in the range of 1:1. Consequently, this requires an alteration in traditional fluid replacement levels. This also alters the threshold of what has been traditionally considered "large"-volume liposuction so that the traditional 1500 ml defining large-volume aspirate may no longer be applicable. To achieve consistency in reporting, all liposuction data should be standardized to routinely include the volumes of injectate, aspirate, and infranatant fluid fractionation.

Use of large volumes of dilute local anesthetic with epinephrine has proven an effective method for reducing blood loss and increasing the volume of fat aspirates in liposuction surgery.1-7 The concept is based on the principle that larger volumes of wetting solutions injected slowly are less toxic in the same milliliter dosage than in more concentrated form. Popular formulas call for the infusion of approximately 3 ml of solution per 1 ml of estimated lipoaspirate until tissue turgor and blanching are achieved. Concentrations of 35 ml/kg and up to 55 ml/kg or more of lidocaine have been tolerated, corresponding to (plasma) serum levels of 0.9 to 3.6 µg/ml, peaking 8 to 14 hours after surgery.8,9 This is in contrast to lidocaine 1% 5 to 7 mg/kg (1 ml = 10 mg) that have been the "standard," (the Physicians Desk Reference recommendation is based on procaine). In this technique no systemic anesthetic is administered. Furthermore, as a result of hypodermoclysis, it provides adequate hydration.

The toxic dose of local anesthetic depends on such factors as the total milligram dosage, the concentration, and the type of local anesthetic.10 There is a linear correlation between the injected dose and the plasma concentration of lidocaine.11 The systemic absorption and serum
levels of lidocaine are affected by the presence of vasoconstrictors, the site of injection (e.g., vascularity, scarring), the pH of the solution, possibly the speed of injection, hepatic function, age of the patient, and the body surface area of the patient. Factors that have been proposed for the delayed absorption of lidocaine include the fact that it is relatively lipid soluble and that fat is known to bind local anesthetic; the poor vascularity of adipose tissue; the low concentration of lidocaine in the solution used; the tension created by the fluid (which increases interstitial pressure and diminishes its uptake); and alkalization of the solution, which increases the amount of nonionized lipid-soluble base, causing a more rapid inflow into the nerve cell and leaving less ionized lidocaine outside available for systemic uptake.\textsuperscript{13-14} In addition, it has been stated that 10\% to 30\% of the injected fluid is removed during liposuction\textsuperscript{6} and, hence, is not absorbed. However, plasma lidocaine levels at less than 1 \( \mu \text{g/ml} \) can result in subjective symptoms of toxicity, and excessive levels can result in cardiac arrest and death (Figure 1).

The advantages of this technique for regional anesthesia during liposuction have been well documented (Figure 2). Others have suggested disadvantages that include the possibility that toxic levels of lidocaine will be reached after the patient has left the surgical facility; the potential for fluid overload causing pulmonary or cardiac decompensation; the time-consuming nature of the injection (which can leak out during infiltration); an adjustment in the preoperative estimate of fat volume removal; an alteration in the tactile or visual end point of liposuction; and inadvertent emptying of the superficial fat compartment, leading to long-term tissue laxity. Moreover, remaining fluid can result in persistent drainage requiring multiple, open-wound sites, the need for drains, prolonged edema, or repeated seroma formation.

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**Figure 1.** Plasma lidocaine levels, correlated with symptoms.

<table>
<thead>
<tr>
<th>Plasma Lidocaine Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 6 ( \mu \text{g/ml} )</td>
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<tr>
<td>5 - 9 ( \mu \text{g/ml} )</td>
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<tr>
<td>8 - 12 ( \mu \text{g/ml} )</td>
</tr>
<tr>
<td>12 - 14 ( \mu \text{g/ml} )</td>
</tr>
<tr>
<td>20 ( \mu \text{g/ml} )</td>
</tr>
<tr>
<td>26 ( \mu \text{g/ml} )</td>
</tr>
</tbody>
</table>

**Figure 2.** Reported advantages and disadvantages of tumescent technique.

**Tumescent Anesthesia**

**Potential Advantages**

- Blood loss
- Bruising
- Vol. fat removal
- Faster recovery
- Less pain
- No sedation or anesthesiologist
- Immediate discharge

**Potential Disadvantages**

- High plasma levels of lidocaine reached after discharge
- High fluid volumes, potential pulmonary/cardiac problems
- Injection time
- Adjustment in SAL endpoint
- Drains
- Potential seroma formation
- Prolonged edema
- Open wounds
- Prolonged drainage
Series of 20 consecutive patients

<table>
<thead>
<tr>
<th>Case</th>
<th>Sites</th>
<th>Injectate (cc)</th>
<th>Aspirate (cc)</th>
<th>Fractionation (cc)</th>
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<tbody>
<tr>
<td>1</td>
<td>Abdomen, inner thighs, neck</td>
<td>2700</td>
<td>5000</td>
<td>800</td>
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<tr>
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<td>3000</td>
<td>4400</td>
<td>800</td>
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<tr>
<td>3</td>
<td>BLT</td>
<td>1500</td>
<td>1700</td>
<td>300</td>
</tr>
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<td>4</td>
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<td>1500</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>2' abdomen, 2' chest, flanks</td>
<td>2500</td>
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<td>500</td>
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<tr>
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<tr>
<td>10</td>
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<tr>
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<td>1800</td>
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<tr>
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<tr>
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<td>3000</td>
<td>3600</td>
<td>800</td>
</tr>
<tr>
<td>20</td>
<td>Abdomen, flanks</td>
<td>2000</td>
<td>2200</td>
<td>500</td>
</tr>
</tbody>
</table>

KCA, knees, calves, ankles; BLT, buttocks, love handles, thighs; 2', secondary.
The fractionation represents the fluid that settled in the infranatant over the first hour.

(Figure 2).\textsuperscript{15,16} Some may consider the absence of an anesthesiologist or early discharge of patients to be imprudent.

The purpose of this study was to review my experience with superwet\textsuperscript{17,18} anesthesia in patients exceeding the traditional large-volume (>1500 ml) suction-assisted lipectomy (SAL) level and to determine the change in typical liposuction volumes as a consequence of these methods.

Patients and Methods

A consecutive series of 25 patients undergoing liposuction, treated by the author, were selected for review. Twenty of those with volumes exceeding 1500 ml were included in this series (Table). To determine the merits of the anesthetic method alone, variables such as superficial suction lipectomy, syringe liposuction, ultrasound-assisted liposuction, or combined SAL and open procedures were not included in this series. Sixteen patients were women, four were men, with an age range of 19 to 66 years of age. Most procedures were performed on an ambulatory basis. Various sites were treated, including neck, arms, abdomen, back, thighs, knees, calves, and ankles, with several patients having multiple treatment sites.

Patients were prepared for surgery by use of reported protocols, including appropriate laboratory data, adequate hydration, and antimicrobial washing. When possible they were marked in a standing position, before being medicated, in front of a three-way mirror to verify the treatment sites. Intravenous hydration and sedation (by use of Propofol\textsuperscript{8}, Fentanyl\textsuperscript{8}, and Versed\textsuperscript{8}) was monitored by an anesthesiologist. All patients received antibiotics and steroids. The site for introducing the superfet solution (and later the cannula) was injected with lidocaine 1% and epinephrine 1:1000. "Stab-wound" incisions were well-hidden and were subsequently closed with sutures.

A wetting solution of local anesthesia fluid (Figure 3) containing injectate 0.5 to 1.5 ml per estimated milliliter of aspirate was infused. The injection consisted of Ringer's lactate solution 1 L, lidocaine 1% 25 to 50 ml (depending on systemic anesthesia and total volume required) and epinephine 1:1000 1 ml. Injection was done with a 14 to 16 gauge mul-
tiport, reusable injection needle under high pressure (300 mm Hg) at a rapid infusion rate of 200 to 300 ml/min.

After infiltration of local anesthesia, a sufficient time interval was allowed for diffusion of the anesthetic. In circumstances necessitating alterations in position, the anesthetic was injected with the patient in the supine position; the patient was then turned to the prone position and injected, and suction was commenced. Before the patient was returned to the supine position, intravenous sedation was diminished, the patient was assisted in repositioning when possible, and suctioning was continued. A variety of multilumen cannulae and a vacuum machine were used.

After surgery patients were placed in snug-fitting elastic compression binders. In patients with poor skin tone, the skin was taped, and Reston® foam was occasionally used.20 Patients were observed in the recovery room until their conditions were stable for discharge. All patients but one were in American Society of Anesthesiologists Physical Status I. They telephoned on reaching their discharge destination; the staff called them that night and the next day; and they were seen at 48 hours by the staff. Postoperative lymphatic massage and ultrasound treatments were recommended, although their efficacy has not been clearly established.

**Results**

The average volume of fluid injected was 2285 ml (range 1500 to 3800 ml), and the average volume of fat aspirated was 2437.5 ml (range 1500 to 5000 ml). The average fluid volume fractionated from the aspirate infranatant was 507.5 ml (range 250 to 800 ml), and the amount of injectate absorbed was 1775.5 ml (2285 - 507.5 ml). The "pure fat" fractionation was 1930 ml (2437.5 - 507.5 ml).

Approximately 21% to 22% of injected fluid is not absorbed (507.5 ml, although a portion of the infranatant is blood). Consequently, the ratio of fat removed to fluid absorbed by hypodermoclysis approached 1:1. The aspirate was fractionated by allowing it to settle undisturbed for a minimum of 15 minutes (Figure 4).

All patients reported being definitely satisfied or satisfied with the results of surgery. One patient had mild, persistent edema in the inner thighs that responded to lymphatic massage, diuretics, elevation, and time. One patient requested a revision of the inner thigh-knee area.

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**Figure 3.** A, The superwet formula for regional anesthesia in suction-assisted lpectomy. B, With the above formula, the volume of injectate fluid (in liters) and milliliters of lidocaine (50 ml/L) that can be used without exceeding 35 mg/kg of lidocaine.

**Figure 4.** A, Average injectate, aspirate, and fluid fractionates. B, The net (pure) fat and amount of injectate not absorbed. This is useful for determining additional patient fluid requirements.
Figure 5. A and B, Front preoperative and postoperative views of a 21-year-old woman who had liposuction of the arms, anterior thighs, lateral and medial thighs, and calves. C and D, Posterior preoperative and postoperative view of the same patient. The fractionals are: 4000 ml were infused, 4350 ml were aspirated. The infranatant contained 800 ml fluid.

No cases of systemic fluid, lidocaine, or anesthetic complications were reported. Aspirates tended to accumulate more blood as surgery reached its end point. Blood hemoglobin and lipocrit levels were not measured. Patients were not typed and cross-matched for blood, and no patients required blood transfusions.

Discussion

Superwet anesthesia seems to have many of the same advantages that have been reported with tumescent anesthesia, that is, less blood loss and bruising, the possibility of larger volumes of fat removal, analgesia, hydration, and patient cooperation, although a lower total milligram dosage of lidocaine and volume of fluid are used. Drains or extra drainage incisions are not required, and persistent edema and seromas seem less common. The amount of injectate was based on an estimate of fat aspiration, body surface area, number and vascularity of sites being injected (or presence of scars), and the achievement of skin blanching and moderate tension.

With these methods and waiting for tissue blanching and moderate tension after injection, the traditional tactile and visual end points of liposuction evaluation are maintained, potentially avoiding subsequent contour problems. Furthermore, the subcutaneous fat compartment is less likely to be inadvertently overemptied (Figure 5).

Lidocaine

Because lidocaine toxicity can mimic certain postoperative signs and symptoms (e.g., light-headedness, shivering, euphoria, drowsiness), achieving similar aesthetic results with lower doses is advantageous. Repeated experience with lidocaine doses of 35 mg/kg have proven that it is safe and efficacious, in spite of correspondence to plasma lidocaine levels of 0.9 µg/ml. However, exceeding these levels clearly places a patient in the plasma range where objective lidocaine toxicity is possible. Furthermore, it has not been shown to be of any additional benefit, and rapid infusion of the solution can be expected to be safer at lower doses.

Lidocaine concentrations varied from 25 to 50 ml/L injectate. Even with general anesthesia, lidocaine is added because it has been postulated that with it there is a faster sensory return and some postoperative analgesia may occur with its use.

Fat Removal

With this technique a larger amount of fat can theoretically be removed with similar doses of local anesthetic than are recommended with tumescent anesthesia, without altering injectate/aspirate ratios, as would be required with increasing volumes of fat removal in the tumescent procedure. For example, use of tumescence in a 70 kg person to suction 5 L of fat, 15 L of injectate are recommended, which far exceeds 35 mg/kg of lidocaine. Looking at this another way, to continue to follow the 3:1 tumescent rule, 5 L would be injected and 1666 ml of fat could be suctioned. With the superwet method, 5 L would be injected and removed. Thus an alter-
In accumulating this series of patients \( n = 20 \) with more than 1500 ml of suction lipectomy, 25 patients were treated; five patients from the consecutive group were excluded because they did not meet study criteria. This implies that the average volumes that are being suctioned tend to be larger than in previous reports and that the traditional level of liposuction volumes may exceed this.

**Fluids**

The combination of fluid absorption resulting from hypodermoclysis and aspirates that are less bloody necessitates an adjustment in hydration levels. Our results indicate that patients absorb approximately 1 ml of the injectate fluid per milliliter of fat aspirate. Twenty percent of the injectate is not absorbed, because it is removed by SAL. Therefore fluid replacement is necessary to supplement the injectate, so that the total intake of injected, intravenous, and postoperative fluid is 2 to 3 ml/ml of aspirate over the course of the first day of surgery. This is adjusted according to clinical parameters. If objective data are necessary, a urine output of 1 to 2 ml/kg/hr would be the goal. Anesthesiologists familiar with the old "rule" of replacing 3:1 intravenously should be alerted to this alteration in fluid requirements. A small portion of the infranatant typically represents blood. For example, in 1000 ml of aspirate, 200 ml of injectate might be suctioned out, and 10 to 100 ml or less (1% to 10%) of the total (1000 ml) might be blood.

**Solution of the total (1000 ml)**

Normal saline solution (sodium = 154 mEq, pH 5) or Ringer’s lactate solution (sodium = 130 mEq, pH 6.5) can be used. The addition of bicarbonate (10 ml of 8.4%) to alkalize the fluid is advised when normal saline solution is used.\(^{22}\) This is advantageous in diminishing the pain of injection and also because it leaves less ionized lidocaine outside the cell for uptake.\(^{23}\) However, altering the pH of the solution has the potential for changing the effectiveness of the epinephrine. Warmed and room-temperature injectate have been used.

**Epinephrine**

Not exceeding epinephrine doses of 0.07 mg/kg is recommended, although doses as high as 10 mg (of 1:1000) have been safely used. With the superwet formula, 0.07 is approximately the dose patients will receive (e.g., a 70 kg person receiving 5 L of superwet injectate with 1 ml of epinephrine per liter will receive 4.9 ml of epinephrine.)

In spite of the fact that the minimal effective concentration of epinephrine is reported to be 1:800,000, the less concentrated doses that are being used (1:1,000,000) are still effective as evidenced by blanching and reduced blood loss—this is due to a longer waiting period and possibly an increased interstitial compressive effect of the fluid. With this technique, the onset of action (normally approximately 8 minutes with peak serum concentrations at 30 to 60 minutes) is delayed to 15 to 20 minutes, with peak serum levels occurring 8 to 14 hours after infusion.\(^{24}\) Consequently, the beginning of surgery is delayed waiting for the epinephrine to take effect.

In this study lipocrit and hematocrit levels were not obtained. Previous reports confirm aspirates with levels in a 1% to 10% range and hematocrit drops in the range of 2% to 4%.

**Local/Systemic Anesthesia**

It should be emphasized that comparing different wetting techniques is not a comparison of "general" anesthesia with "local" anesthesia. Systemic anesthesia is not necessarily the germane issue; however, the combination of superwet local anesthesia and intravenous sedation can be expected to reduce the requirements of either alone. Furthermore, in spite of the development of rapid injection systems, the discomfort encountered with the injection of local anesthesia often limits the speed of injection. Systemic anesthesia is useful in countering this and in maintaining comfort in areas such as the upper abdomen, costal margins, medial thighs, mons pubis, or scarred areas, which have a tendency to be more difficult to anesthetize and require higher concentrations of local anesthetic for adequate analgesia. An essential component to the instillation of the local anesthetic solution is its even distribution in the adipose tissue.

Before using any large volume local anesthesia technique, the surgeon should be thoroughly familiar with the pharmacokinetics of lidocaine and epinephrine used in this fashion. Continual awareness of the injection volume/patient weight correlation and its relation to plasma lidocaine levels must be noted.

**Other Areas**

Superwet anesthesia has been used to perform surgery in other areas where hydrodissection, hypodermoclysis, and reduced blood loss would also be advantageous. In spite of the obvious advantages, I would caution the routine extrapolation of any high-volume local anesthetic techniques to other areas. The safety and efficacy of high-volume wetting techniques is dependent on the poor vascularity and binding of lidocaine by adipose tissue, and the spongelike uptake of the fluid by adipocytes. (Other tissues may not do this and
Indeed may be more vascular.) These factors result in delayed absorption of the fluid. Indeed, pathologic examination of fat cells containing increasing amounts of injectate reveal a proportionate expansion in cell size. Also, with liposuction surgery, unlike other procedures, a portion of the injectate will be removed. Moreover, patients generally require more fluid replenishment after liposuction than after other procedures.

**Conclusion**

The introduction of wetting solutions with high volumes of fluid and pH-adjusted lidocaine and epinephrine has been suggested by a number of surgeons and is a concept based on delayed absorption of the fluid. Indeed, pathologic examination of fat cells containing increasing amounts of injectate reveals a proportionate expansion in cell size. Also, with liposuction surgery, unlike other procedures, a portion of the injectate will be removed. Moreover, patients generally require more fluid replenishment after liposuction than after other procedures.

**References**

20. Matarasso A. Superficial suction lipectomy; something old, something new, something borrowed... Ann Plast Surg 1995;34:268.