The Tumescent Technique for Lipo-Suction Surgery*

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Abstract

The tumescent technique of lipo-suction is a modification of the wet technique. A large volume of very dilute epinephrine is infiltrated into a targeted fat compartment prior to lipo-suction, producing a swelling and firmness. This tumescence of fat permits an increased accuracy in lipo-suction and minimizes postsurgical irregularities or rippling of the skin. Epinephrine-induced vasoconstriction minimizes blood loss, bruising, and postoperative soreness.

Safe, rapid infiltration of large volumes of solution is achieved using a closed sterile system featuring a newly designed blunt-tipped, 30-cm-long, 4.7-mm-diameter needle having a hollow handle that accommodates a 60-cc syringe. Attached to a liter bottle of anesthetic solution by an intravenous line, the needle is inserted via the same incision and deposits the solution along the same path as that intended for the lipo-suction cannula. Thus, the solution is infiltrated exactly where it is needed for hemostasis or local anesthesia.

Used in conjunction with general anesthesia, the tumescent technique saves time in achieving maximal vasoconstriction of the targeted fat compartment. If dilute lidocaine (0.1%) is added to the solution, the technique permits lipo-suction of more than 2 liters of fat totally by local anesthesia. Twenty-six patients, having received a mean lidocaine dose of 1250 mg (18.4 mg/kg or 8.5 mg/kg/hr) infiltrated into subcutaneous fat, had a mean serum lidocaine level of less than 0.36 μg/ml 1 hour after completion of the infiltration.

Introduction

Lipo-suction by general anesthesia, without local infiltration of epinephrine, is associated with potentially serious blood loss and massive bruising. Until now, the time-consuming inefficiency of multiple percutaneous injections has discouraged the use of vasoconstrictors and local anesthesia for lipo-suction.

This article describes the clinical pharmacology and instrumentation of the tumescent technique. When used with general

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anesthesia, the tumescent technique improves the efficiency and clinical results of the wet technique. When lidocaine is added to the infiltrate, the technique permits the safe and efficient removal of over 2 liters of bloodless fat by lipo-suction totally by local anesthesia.

Methods and Materials

When the tumescent technique is used with general anesthesia, the concentration of epinephrine is 1:1,000,000. This vasoconstrictive solution is prepared as follows:

1. One-liter intravenous (IV) bottle of sterile physiologic normal saline (0.9% NaCl).
2. One ampule (1 ml) of 1:1,000 epinephrine.

In this study, local anesthesia was used. The solution, consisting of lidocaine (~0.1%) and epinephrine (~1:1,000,000) in normal saline, was prepared as follows:

1. One-liter IV bottle of sterile physiologic normal saline (0.9% NaCl).
2. Two 50-ml bottles of 1% plain lidocaine (1 gm of lidocaine).
3. One 1-ml ampule of 1:1000 epinephrine (1 mg of epinephrine). The exact concentrations are lidocaine 0.091% and epinephrine 1:1,100,000.

A new instrument (patent pending) consisting of a blunt-tipped 30-cm-long stainless-steel needle is employed to infiltrate the anesthetic. It has an outside diameter of 4.0 mm, an inside diameter of 1 mm, and is welded to a 10-cm-long hollow handle that accommodates a 60-cc disposable Luer-Lock syringe (see Figure 1). Interposed between needle and handle is a fluid intake port connected to an IV bottle containing the local anesthetic solution by an IV line. By inserting the needle through the same incisions and infiltrating along the same paths intended for the suction cannula, the solution of anesthetic and vasoconstrictor is deposited in fat exactly along the path where it is needed. The blunt tip precludes inadvertent intravascular drug delivery and minimizes the risk of sharp trauma to structures in and about the targeted deposits of fat.

The IV line connecting the bottle of anesthetic solution to the large needle is the "ADDitIV Primary IV Set" (catalog no. V1446, manufactured by McGaw Laboratories, Inc.). It is equipped with a "macrodrip" drip chamber, and a built-in check valve that prevents retrograde flow of anesthetic solution.

The 60-cc syringe is filled initially by attaching it to the IV line using a (B-D) syringe-filling connector (reorder number 5225, Becton-Dickinson, Rutherford, NJ 07070).

A peripheral IV is maintained during surgery to deliver diazepam (Valium) as needed in 2.5- to 5-mg increments. To avoid an inadvertent switch of solutions, we suggest a plastic bag to contain the peripheral IV solution and a glass bottle to contain the anesthetic solution. Cardiac rhythm is monitored continuously, with a regular printout of ECG rhythm strip and blood pressure.

Felt-tipped indelible ink pens are used to mark the patient's skin. Straight lines radiating from the incision sites mark the

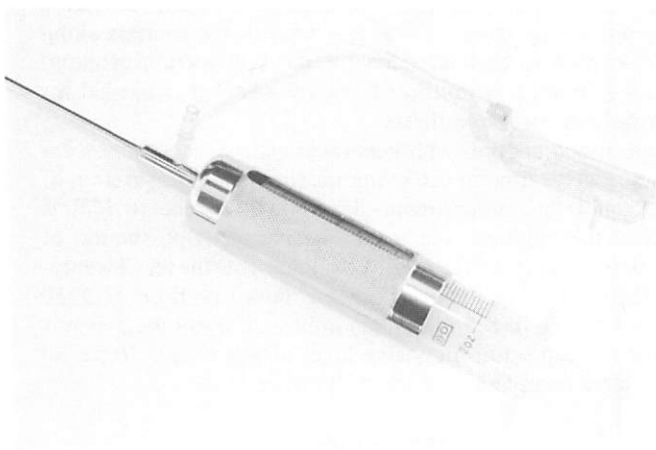

Figure 1. *The handle portion of the Klein Needle (shown here) accommodates a 60-cc syringe with a Luer-Lock attachment. The needle portion of the Klein Needle is 12 inches long. This new surgical instrument is attached to an IV bottle containing the vasoconstrictor/anesthetic solution by an IV line, as shown.*

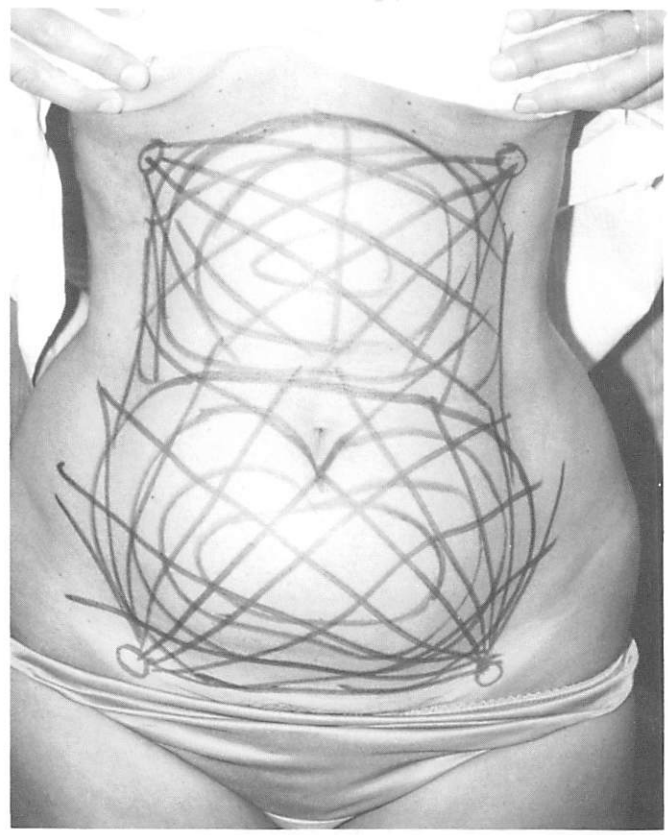

Figure 2. *Lines drawn on patient's abdomen prior to lipo-suction surgery. Straight lines indicate path along which the Klein Needle deposits the solution of anesthetic and vasoconstrictor. Curved lines represent the topographical contours of targeted fat compartments.*

paths for the anesthetic needle. The lines, at most 5 cm apart, provide a grid pattern that assures uniform infiltration of anesthetic solution (see Figure 2).

We studied 26 patients who had lipo-suction by local anesthesia. Peripheral venous blood for serum lidocaine levels was obtained 1 hr after completing the infiltration with local anesthetic. Serum levels of lidocaine and its two principal metabolites, monoethylglycylxylidide (MEGX) and glycylxylidide (GX) were obtained by gas-liquid chromatography with a sensitivity level of 1 ng/ml.[1]

In a separate study peripheral venous blood was obtained prior to surgery and again 48-72 hr after surgery, in 10 patients, to determine postoperative change of hematocrit.

Details of the Technique

The 60-cc syringe is initially filled by attaching it directly to the anesthetic IV line using a B-D syringe-filling connector. Once it is full, the syringe is then fastened to the needle handle, which in turn is attached to the bottle of anesthetic by the IV line, as shown in Figure 3.

The needle is then inserted via the same incision and advanced through subcutaneous fat along the same paths intended for the lipo-suction cannula. Continuously palpating the needle tip, the surgeon advances the needle carefully, pausing every 2 to 4 cm to deposit 2 to 4 ml of anesthetic solution.

When general anesthesia is used, rapid infiltration of the solution is desirable. This is achieved by leaving the flow-rate regulator open once the needle tip is in the subcutaneous fat. By using an IV line with a built-in check valve, reflux of solution is prevented when the syringe plunger is depressed. Once the syringe contents has been deposited into fat, the syringe is refilled merely by retracting the syringe plunger, with the needle tip remaining in the subcutaneous fat. With this arrangement, there is no need for a three-way stopcock to regulate direction of fluid flow.

When local anesthesia is used, infiltration of the solution is slower and more controlled. Closing the flow-regulator clamp while infiltrating prevents the continuous gravity-induced infiltration of the anesthetic during the pauses when not actively pushing the syringe plunger. This conserves anesthetic and allows a more uniform infiltration. There is surprisingly little discomfort with this technique. As the needle is advanced along its initial path, the patient will experience a mild burning discomfort as the anesthetic is injected. Once the initial path is anesthetized, subsequent infiltrations along adjacent paths cause less discomfort. Occasionally the needle tip encounters a fibrous septum that is difficult to penetrate. By injecting a small bolus (3–4 ml) of anesthetic and waiting a few seconds, one may proceed without causing pain. The periumbilical area, upper abdomen, and posterior-lateral thighs are particularly sensitive, and will usually require a little extra local anesthesia infiltrated using a 20-gauge spinal needle. After one fat compartment has been anesthetized, lipo-suction is completed before treating another compartment. This minimizes the systemic absorption of lidocaine.

The range of volumes of solution necessary to anesthetize a given anatomic fat compartment are as follows:

Entire abdomen: 400–1200 cc
Two lateral thighs ("saddle bags"): 500–1000 cc

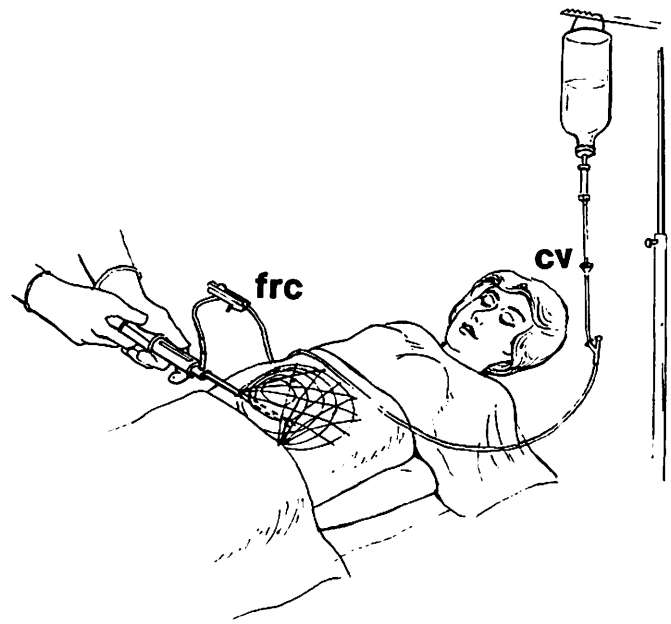

Figure 3. *The Klein Needle allows deposition of vasoconstrictor/anesthetic solution exactly along the paths intended for the lipo-suction cannula. The IV line has a one-way check valve (cv) that prevents retrograde flow. After inserting the tip of the Klein Needle into the subcutaneous fat and opening the flow regulator clamp (frc), the syringe is filled (or emptied) simply by pulling (or pushing) on the syringe plunger. This sterile, closed system reduces the time required to infiltrate solutions into large subcutaneous fat compartments.*

Two medial thighs: 400–800 cc
Two upper hips ("love handles"): 400–800 cc
Two knees: 300–600 cc
Submental area: 50–100 cc

Incisions are closed with 6-0 nylon interrupted sutures and removed 7 days later. Postoperative drainage of pink-tinged residual anesthetic solution stops within 12 to 24 hr. Because of minimal bleeding and bruising associated with the tumescent technique, an elastic support garment is only strictly required the first 5 days postoperatively. Some patients prefer to wear the garment for 10–14 days for comfort and support. Beginning 24 hr after surgery, patients may remove their elastic garment briefly for a daily shower.

Results

Using the tumescent technique 26 patients (22 female, 4 male), whose mean weight was 69 kg, received a mean total dose of 1250 mg of lidocaine (range: 825 mg to 3100 mg) infiltrated into subcutaneous fat over a 1–5 hr interval. The mean dosage of lidocaine was 18.4 mg/kg of body weight, and the mean lidocaine dosage per unit time was 8.5 mg/kg/hr.

The mean volume of tissue extracted by suction was 1167 ml, of which 915 ml was fat. The remaining 252 ml was slightly blood-tinged anesthetic solution with less than 1.5% packed red cell volume.

The mean serum lidocaine and metabolite levels were: lidocaine = 0.336 μg/ml; MEGX = 0.052 μg/ml and GX = 0.023 μg/ml. The highest serum lidocaine level among the 26 patients was 0.614 μg/ml.

In a separate study of 10 patients, the mean change in hematocrit was 0% ± 1.8%, measured 48–72 hr after lipo-suction, and the mean volume of tissue extracted was 1025 ml.

Discussion

The tumescent technique provides a more rapid and safer means of infiltrating dilute epinephrine into targeted fat compartments for lipo-suction than the traditional wet technique using multiple percutaneous injections. It permits lipo-suction of large volumes of almost bloodless fat.

Using the tumescent technique with lidocaine provides an especially safe and efficient method for doing lipo-suction by local anesthesia. The lidocaine is deposited exactly along the eventual pathway of the lipo-suction cannula.

When epinephrine-induced vasoconstriction is the principal goal of the tumescent technique, lidocaine should be omitted from the infiltrated solution. One commonly recommended recipe for the solution infiltrated in the wet technique uses 250 ml of saline (0.9%), 75 ml of lidocaine (1%) with epinephrine 1:100,000, and 300 units of Wydase.[2] This formulation contains 750 mg of lidocaine. One must be aware of an important lidocaine–epinephrine drug interaction. Although epinephrine delays lidocaine absorption from subcutaneous tissue, lidocaine accelerates the systemic absorption of epinephrine.[3] Lidocaine causes vasodilation [4,5] and reduces the vasoconstrictive ability of epinephrine. Furthermore, the large volumes used in the tumescent technique guarantee wide diffusion of the epinephrine; thus, Wydase is unnecessary.

For local anesthesia, the traditional maximum recommended single dose of lidocaine with epinephrine is 7 mg/kg.[6] Lidocaine blood levels above 6 μg/ml are considered potentially toxic. However, the safe maximal dosage varies widely depending on site of infiltration. The maximal dosage has been well studied for use in highly vascular areas such as in paracervical blocks used in obstetrics, in peripheral nerve blocks, and in epidural anesthesia. An extensive search of the literature failed to find any documentation of dosages for infiltration of lidocaine into subcutaneous fat. In the present study, 26 patients received a mean dose of 1250 mg of lidocaine. The mean maximal lidocaine blood level was 0.336 μg/ml. The highest lidocaine serum level in any patient was 0.614 μg/ml as measured by gas-liquid chromatography.

Pharmacologic principles explaining the tumescent technique's success are as follows:

1. For a given amount of lidocaine injected subcutaneously, the more dilute the solution, the safer it is. The median lethal dose (LD_{50}) of subcutaneous lidocaine in mice increases with increased lidocaine dilution.[7]
2. The larger the volume of an injected anesthetic solution, the greater its diffusion and the more uniform the resulting anesthesia.
3. Dilute solutions of lidocaine with epinephrine produce very good cutaneous anesthesia, albeit for a shorter duration than standard concentrations.[8,9]

Despite the unusually large amount of lidocaine used with the tumescent technique, systemic lidocaine absorption is remarkably low. There are several pharmacologic factors that may explain this observation:

1. Lidocaine has a relatively high lipid and low water solubility. A large fraction of the lidocaine dose is partitioned into fat and then extracted by lipo-suction.
2. Systemic absorption of subcutaneous lidocaine is a function of the blood perfusion rate of local tissue. The relative avascularity of fat and epinephrine-induced vasoconstriction account for the slow lidocaine uptake into the systemic circulation.
3. With a first-pass hepatic extraction ratio of 0.7, lidocaine is rapidly metabolized by the liver.[10] In other words, 70% of the lidocaine content in a volume of blood is removed with a single pass through the liver. To the extent that epinephrine increases cardiac output and therefore hepatic blood flow, the hepatic metabolism of lidocaine is accelerated. The small amount of lidocaine metabolites detected by gas-liquid chromatography in the present study indicates that only a small amount of lidocaine is actually absorbed.

The large volume of solution is an important aspect of the tumescent technique. The injection of copious amounts of fluid increases the cross section and firmness of a targeted fat compartment. When the infiltration is uniform the fatty compartment is magnified without distorting its relative proportions. A larger tumescent fatty compartment permits lipo-suction which is more accurate and uniform. It helps reduce the incidence of locally excessive fat extraction.

Conclusion

Lipo-suction by the tumescent technique offers several important advantages over older techniques: (1) improved efficiency compared to wet technique; (2) less bleeding; (3) better cosmetic results; (4) more rapid postoperative recovery; and (5) reduced risk of lidocaine toxicity.

References

1. Adjpon-Yamoah KK, Prescott LF: Gas-liquid chromatographic estimation of lignocaine, ethylglycylxylidide and 4-hydroxyxylidine in plasma and urine. *J Pharm and Pharmacol* 26:889–893, 1974.

2. Hetter GP: The effect of low dose epinephrine on the hematocrit drop following lipolysis. *Aesth Plast Surg* 8:19, 1984.

3. Ueda W, Hirakawa M, Mori K: Acceleration of epinephrine absorption by lidocaine. *Anesthesiology* 63:717–720, 1985.

4. John RA, DiFazio CA, Longnecker DE: Lidocaine constricts, dilates rat arterioles in a dose-dependent manner. *Anesthesiology* 62:141–144, 1985.

5. Henriksen O: Local reflex in microcirculation in human subcutaneous tissue. *Acta Physiol Scand* 97:447–456, 1976.

6. Ritchie JM, Green NM: *Goodman and Gilman's Pharmacologic Basis of Therapeutics*, 7th edition. New York, Macmillan, 1985, p. 313.

7. Gordh T: Xylocaine—a new local analgesic. *Anaesthesia* 4:4–9, 21, 1949.

8. Carnegie DM, Hewer AJH: Clinical trial of xylocaine in local anesthesia. *Lancet* 2:12–14, 1950.

9. Covino BG, Vassallo HG: *Local Anesthetics—Mechanisms of Action and Clinical Use*. New York, Grune & Stratton, 1976, p. 63.

10. Stenson RE, Constantino RT, Harrison DC: Interrelationship of hepatic blood flow, cardiac output, and blood levels of lidocaine in man. *Circulation* 43:205, 1971.

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