Mega-Dose Lidocaine Dangers Seen in 'Tumescent' Liposuction

[Editor's Note: Recent reports in the lay press and in professional publications (see the *APSF Newsletter*, Summer 1999) of significant adverse patient outcomes associated with current liposuction techniques that are often performed in the offices of plastic surgeons have raised concerns about the safety of these procedures for patients. One of anesthesiology's foremost experts on local anesthetics provides here valuable background information on this issue.]

by Rudolph H. de Jong, M.D.

Although open lipoplasty, the surgical excision of ungainly body fat, is available, it rarely is practiced because of likely unsightly scars and prohibitive blood loss. The Bikini swimwear fashion sweeping the 1960s fueled the search for a less disfiguring and less bloody cosmetic procedure, culminating in the cannula aspiration of subcutaneous fat deposits through strategically placed near-invisible stab incisions: liposuction.

However, the considerable flow shear of semi-liquid fat and the unavoidable tearing of small blood vessels functionally placed a physiologic cap on the aspirated tissue volume. The introduction of "wetting" — injecting hypotonic fluid to lyse adipose cell walls and emulsify fat — paved the way for high-volume thin-cannula aspiration. Still, intraoperative bleeding and postoperative oozing remained formidable obstacles. The pharmacologic hemostasis attained when epinephrine was added to wetting solution proved a landmark, and virtually bloodless aspiration of several liters of fat became practical reality. Soon, outpatient 'liposuction' under general anesthesia began to flourish and became *the* most common aesthetic surgery procedure by 1997.

Tumescent Anesthesia

Although plastic surgeons experimented sporadically with adding local anesthetic to the wetting solution, the incentive was limited. The breakthrough arrived in 1987 when Jeffrey Klein, a California dermatologist, reported on clinical trials with subcutaneous infiltration of several liters of wetting solution containing highly diluted (0.05% to 0.10%) lidocaine with epinephrine 1 mg/L (1:1,000,000).[1] Cleverly dubbed 'tumescent' technique because of the taut stretching of overlying blanched skin, Klein demonstrated local analgesia entirely adequate for liposuction, virtually bloodless aspirates, prolonged postoperative analgesia and — flying in the face of conventional two-compartment lidocaine kinetics — slow but sustained tissue release of lidocaine with maximum mean serum levels of 1.3 mg/L (1.3 μg/ml) peaking some 12 to 14 hours after injection, then declining gradually over the next 6 to 14 hours.[2] In other words, lidocaine, when highly diluted, emulates a one-compartment lidocaine-disposition model not unlike the kinetic profile for sustained-release medication.

Klein further demonstrated that — contrary to popular belief — the 'safety' (as evidenced by subtoxic peak lidocaine blood levels) of tumescent local anesthesia lay not so much in the immediate suction removal of lidocaine-containing wetting solution, but rather in the substantial tissue binding of injected lidocaine.[2] Tumescent anesthesia truly revolutionized liposuction as the procedure now could be performed painlessly, and virtually bloodlessly, in the doctor's office. Soon physicians, some

with little more surgical training than a weekend seminar, had adopted tumescent liposuction as a lucrative second income generator. Nearly one-half of the quarter million North American liposuctions performed in 1997 were done by practitioners other than plastic surgeons.

Lidocaine Dose Escalation

As ever greater volumes of fat are aspirated to meet rising patient expectations, ever larger volumes of fluid containing ever higher doses of both lidocaine and epinephrine are administered — all too often with just a roving nursing assistant charting patient progress. Nowadays, lidocaine mega-dosing with 35 to 55 mg/kg is considered 'safe' practice[3], and even higher doses of 65 mg/kg lidocaine and up are not at all uncommon. No wonder that concerns over patient safety are heard increasingly. In New York City alone, the Medical Examiners Office attributed no fewer than five deaths to post-liposuction lidocaine toxicity. [4]

The situation is further complicated by the several liters of fluid pumped in rapidly to tissue planes below the skin (not unlike hypodermoclysis), as well as by the frequent patient demand for sedation — not to mention supplemental analgesia. Yet, because mortality after office procedures is not reportable, and because medical examiners largely are unaware of the enormous doses of lidocaine, epinephrine and fluid administered for tumescent liposuction, all too little is known about the safety of this increasingly common elective procedure.

Startling Mortality

That all was not well with liposuction became known to the public with a spate of widely publicized fatalities.[4] Recently, in a census survey of 1200 aesthetic plastic surgeons, we reported 95 verified deaths in nearly half a million lipoplasties, a mortality rate of 1/5,224 (19.1/100,000).[6] And these were deaths representative of only about one-half the total number of lipoplasties performed in North America over the 4 1/2-year period. To place the 19.1/100,000 mortality rate in daunting perspective, it exceeds the 16.4/100,000 fatality rate of 1996 US motor vehicle accidents, and utterly dwarfs the 3/100,000 death rate reported for elective hernia surgery.

PERIOPERATIVE COMPLICATIONS

COMPLICATION	SUB TYPE	CAUSATION
Pulmonary Embolism	thromboembolism fat embolism (FE syndrome)	venous stasis; caval compression procedural fat mobilization
Lidocaine Toxicity	cardiotoxicity (cardiovascular) convulsions (CNS toxicity) hepatic enzyme saturation	conduction/contraction depression surprisingly rare (slow absorption?) drug interaction; relative overdose
Pulmonary Edema	overhydration hypodermoclysis	IV fluid overload tumescent fluid absorption

Organ Perforation	abdominal wall and/or viscera	suction catheter misdirection/mishap
Hemorrhage	Intraoperative postoperative	major vessel perforation coagulopathy; surgical technique
Third Space Fluid Shifts	excessive fat aspiration	extensive subsurface "burn"
Inappropriate Sedation	inadequate local anesthesia	poor patient and/or drug monitoring
Epinephrine Toxicity	hypertension & tachycardia	undocumented (in situ metabolism?)

Lidocaine Mega-Dosing

Of the perioperative complications listed in the above Table, the controversial issue of "safe" lidocaine dosing stands out. As this publication's readers well know, the FDA-sanctioned maximum recommended adult dose of lidocaine (with epinephrine) for regional anesthesia is 7 mg/kg. Yet, for tumescent infiltration anesthesia with highly diluted lidocaine and epinephrine, at least five-fold that dose (35 mg/kg) is considered acceptably "safe" for use in liposuction[2], even doses much higher than that (55 mg/kg, for instance) increasingly are held out to be "safe", absent lidocaine toxicity.[3]

How did that staggering lidocaine dosing discrepancy come about? Empirically, the key difference between nerve block and tumescent anesthesia dosing resides in the lidocaine dilution. A reasonable interpretation may be that the 7 mg/kg lidocaine dose limit applies to out-of-the-bottle undiluted commercial 0.5%, 1% or 2% lidocaine (with epinephrine). Whereas the manyfold higher 35 (or more) mg/kg lidocaine dose ceiling applies narrowly and specifically only to highly diluted (<0.1%) lidocaine (with epinephrine) for tumescent subcutaneous infiltration. Mirroring the 0.1% aqueous phase, one gram of subcutaneous tissue apparently can absorb up to one milligram lidocaine. Any lidocaine above and beyond that retained by 1 mg/gm drug-tissue buffering system remains unbound — free to be absorbed rapidly according to the traditional kinetics of steep rise and swift decline in lidocaine blood level. Imagine the subcutaneous drug reservoir as a baby's cotton diaper that soaks up, and retains, a certain amount of fluid — any more liquid, however, spills over to cause instant mischief.

Lidocaine Dosing Dichotomy

Accepting that healthy adults can handle the subcutaneous infiltration of 35 mg/kg of *highly diluted* lidocaine, our gravest concern is that physicians may overlook the *highly diluted* caveat, conclude that 35 mg/kg lidocaine is the safe dose, then blithely administer several thousand milligrams of 1% or 2% lidocaine — need one say more? That scenario is further complicated when tumescent anesthesia is

given for liposuction, topped by 0.5% or 1% lidocaine infiltration for concurrent cosmetic breast or face surgery.[5]

Safe lidocaine dosing seems to follow either of two rules — one for full-strength out-of-the-bottle commercial product (7 mg/kg), the other for highly diluted (0.05% to 0.10%) tumescent anesthesia solution (35 to 50 mg/kg). Dose limits aside, an additional perplexity with high-dose lidocaine infiltration is the rarity of convulsions. Rather, post-liposuction deaths signed out as "lidocaine toxicity" may well represent the end-stage of local anesthetic depression of cardiac conduction and contractility (progressing to terminal asystole) — not unlike the victims of the 1981 "Xylocaine Mercy Killer".[7]

Fluid Shifts

Anesthesiologists should keep close tabs on the many liters of wetting fluid injected rapidly, and under substantial pressure, beneath the skin. Although most of the fluid is suctioned out in short order, sufficient volume remains to be absorbed systemically, as with old-fashioned hypodermoclysis. Compounding that, the considerable (albeit hidden) trauma caused by removal of several liters of subcutaneous tissue creates a third space void. Thus, conventional approximations to intraoperative IV fluid replacement no longer hold, and hydration status may need to be monitored with a bladder catheter whenever large-volume (more than 4 or 5 liters) liposuction is proposed.[8]

Epinephrine Toxicity

Just as much more lidocaine than usual is administered, so it is with epinephrine. Realize that each liter of tumescent or wetting solution contains 1 mg of epinephrine. As five or more liters of solution may be infiltrated in short order, that seemingly staggering epinephrine load appears to be tolerated without apparent adverse effect.[5] Serum epinephrine levels peaked to 3 to 5 times the upper normal limit (133 μg/ml) at 3 hours, returning to normal at 12-hour sampling.[5] As with lidocaine, extreme dilution may capture epinephrine into tissue, then to be freed gradually for in situ metabolism.

Patient Safety

Clearly, something is remiss in liposuction patient management — whether the procedure itself, the operator, choice of anesthesia, patient selection or intraoperative management. Consistent with the 25-year trend, pulmonary embolism remains the main killer in cosmetic surgery, accounting for roughly one-fourth of the unavoidable deaths. Other surgical complications, however — hemorrhage, perforation or infection — should prove largely preventable through proper operator training. That leaves some two-thirds of perioperative complications (Table) wide open to preventive and/or corrective intervention.

As noted, the potential role of lidocaine cardiotoxicity in tumescent anesthesia remains largely unappreciated. That, plus concomitant perioperative complications such as pulmonary edema or inappropriately administered sedative and analgesic drugs, cry out for the strengthening and enhancement of existing monitoring, resuscitative, and recuperative facilities in physician offices. At the risk of sounding somewhat self-serving, anesthesia services should be consulted — if not engaged — for patient safety monitoring whenever "major" liposuction or conscious sedation are

contemplated, for liposuction may not be as benign a procedure as heretofore inferred.

Dr. de Jong is Professor of Surgery/Anesthesia (Honorary) at the University of South Carolina. A passing inquiry by Dr. Fred Grazer, pioneer in tallying cosmetic surgery complications, about titanic lidocaine dosing in liposuction led to a collaborative clinical mortality study, now in press. Ironically, the initial thrust "was this death attributable to lidocaine toxicity" remains unanswered as yet, for lack of postmortem toxicology. Dr. de Jong is hard at work readying the third edition of Local Anesthetics for the millennium and can be reached at <dejong@AXS2K.net>.

References

1. Klein JA: The tumescent technique for lipo-suction surgery. *Am J Cosmet Surg* 1987;4:263-267.
2. Klein JA: Tumescent technique for regional anesthesia permits lidocaine doses of 35 mg/kg for liposuction. *J Dermatol Surg Oncol* 1990;16:248-263.
3. Ostad A, Kageyama N, Moy RL: Tumescent anesthesia with a lidocaine dose of 55 mg/kg is safe for liposuction. *Dermatol Surg* 1996;22:921-927.
4. Rao RB, Ely SF, Hoffman RS: Deaths related to liposuction. *New Engl J Med* 1999;340:1471-1475.
5. Burk RW, Guzman-Stein G, Vasconez LO: Lidocaine and epinephrine levels in tumescent technique liposuction. *Plast Reconstr Surg* 1996;97:1379-1384.
6. Grazer FM, de Jong RH: Deaths from liposuction: Census survey of cosmetic surgeons. *Plast Reconstr Surg* 1999;104: (in press).
7. Peat MA, Deyman ME, Crouch DJ, et al: Concentrations of lidocaine and monoethylglycylxylidide (MEGX) in lidocaine-associated deaths. *J Foren Sci* 1985;30:1048-1057.