Safety of Liposuction Using Exclusively Tumescent Local Anesthesia in 3,240 Consecutive Cases

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BACKGROUND Many surgeons consider liposuction using tumescent local anesthesia (TLA) to be a safe technique, but when TLA has been combined with other techniques, such as general anesthesia or intravenous medication, or when the guidelines associated with TLA have been violated, serious complications and deaths have occurred. This has resulted in uncertainty concerning the safety of liposuction using TLA, which this article seeks to resolve.

OBJECTIVE To investigate whether liposuction using TLA is a safe procedure.

METHODS The same surgeon performed liposuction using exclusively TLA in 3,240 procedures. Detailed records were kept of the complications that occurred.

RESULTS In a series of 3,240 procedures, no deaths occurred, and no complications requiring hospitalization were experienced. In nine cases, complications developed that needed further action.

CONCLUSIONS Liposuction using exclusively TLA is a proven safe procedure provided that the existing guidelines are meticulously followed.

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For many years, liposuction has been the most performed cosmetic surgical procedure worldwide. After the introduction of liposuction in the 1970s,[1] the introduction of the technique of tumescent local anesthesia (TLA),[2] in which the only form of anesthesia employed is the infusion of a saline solution of an anesthetic (usually lidocaine) in the subcutaneous fat compartment until tumescence is reached, revolutionized the procedure. This TLA technique eliminated most of the medical and cosmetic problems associated with liposuction that had been encountered in the early years. Unfortunately, many physicians, mainly nondermatologists, continued to perform liposuction using the traditional techniques combined with other forms of anesthesia, infiltrating only relatively small amounts of solution with epinephrine to prevent considerable blood loss. Infiltrating only small amounts of anesthetic solution without reaching the state of tumescence was often erroneously described as TLA, and this has contributed to confusion in the definition and terminology related to TLA. Using insufficient solution to reach tumescence led to many cases in which the doctor and the patient both mistakenly presumed that the TLA technique was used. The negligent use of the terms "tumescent liposuction," "tumescent technique," and "tumescent anesthesia" compounded the confusion. To further complicate the situation, surgeons were infiltrating fat compartments in individual patients with small or large amounts of tumescent solution in combination with other types of anesthesia, such as general anesthesia, deep intravenous sedation, or spinal anesthesia. These factors led to rumors and articles that suggested that liposuction performed with the use of tumescent anesthesia could lead to serious complications, but these articles,[3–14] describing the occurrence of serious complications and deaths, reveal that the procedure was not performed in accordance with the strict guidelines required for performing liposuction using exclusively TLA. Deaths from fluid overload caused by intravenous fluid infusion, thrombosis

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after the general anesthesia, and perforation of the intestine are well-known examples.[4,8,9]

The use of TLA as the exclusive method of anesthesia has become the standard in liposuction performed by dermatologists, no report of death after use of this procedure has been published, and serious complications are extremely rare, but strict adherence to the guidelines[15,16] and thorough knowledge of the pharmacological mechanism and of the anesthesiologic aspects of the technique[17] are essential to prevent complications related to using TLA. This article covers all data on liposuction procedures using exclusively TLA performed by the same surgeon on 3,240 patients from 1996 to 2008. To evaluate the safety of these liposuction procedures, all complications requiring further medical action were meticulously documented.

Methods

Patient Selection

Patients contacted the clinic after referral by a doctor, referral by word of mouth, exposure to free publicity in the lay press, or search of the Internet. During consultation, patients were informed extensively of all aspects of the procedure to be performed. Unrealistic expectations and medical contraindications were the two most important criteria whereby an applicant would be excluded from surgery. In the case of patients who suffered from systemic diseases, their doctors were contacted for advice. When the patient's doctor advised that specific measurements or tests be performed before the procedure or that the procedure not be done, this advice was followed. Informed consent of the patient was obtained in all cases.

Technique

The existing guidelines for liposuction using TLA were followed[15] and, when necessary, adjusted to the specific situation in The Netherlands. In the early years, only limited guidelines were available. More recently, newer guidelines and the guidelines (so-called "Fieldnorm") as proposed by Dutch dermatologists and accepted by the Dutch Society for Dermatology and Venerology were followed.

Preoperative Phase

In all treatments, a course of flucloxacillin (500 mg, 4 dd [per day] per os [by mouth]) began on the evening before surgery and was continued for 7 days. Patients allergic to penicillin received erythromycin (500 mg, 4 dd per os), which was replaced in 2003 by clindamycin (600 mg, 4 dd per os). Ingestion of vitamins, alcohol, and medication that influenced coagulation had to be stopped 1 to 2 weeks before the procedure was performed. Patients using medication that interfered with the enzymes cytochrome P4501A2 or P4503A4, by inhibition or competition, were instructed to stop taking this medication or to change to an acceptable alternative medication. If this medication could neither be stopped nor replaced, the maximum lidocaine dosage administered was reduced to 35 mg/kg of body weight. On request, minimal oral sedation was given with diazepam (5 mg) or lorazepam (1 mg), the latter occasionally combined with clonidine (0.075–0.15 mg).

Surgical Technique

Sterility Conditions The procedures were performed in a treatment room without laminar airflow. The surgeon wore a newly laundered, nonsterile cotton surgical costume for each procedure. Hands and arms were scrubbed with soap and chlorhexidine–alcohol. Clean gloves were used during infiltration and sterile gloves during suction. Instruments were sterile. The conditions were described as "clean" and were accepted as adequate by the Dutch national health care authorities.

Preparing Phase The skin was cleaned with alcohol (70%) and a povidone iodine or chlorhexidine scrub. Photographs for documentation were taken, and precise markings were made with the patient in a standing position.

TABLE 1. Constitution of the Tumescent Solution Used

Component	*Quantity*
Sodium chloride 0.9%	1,000 mL
Lidocaine	400–1,000 mg
Epinephrin	0.5–1.0 mg
Sodium bicarbonate	10 mEq

Infiltration Phase Tumescent solution was used (Table 1). A peristaltic infiltration pump was used for infiltration in all areas except for the face and neck, and infiltration was ceased when the tumescent state was reached in deep and superficial planes in the marked area. This results in even total blanching, representing vasoconstriction by epinephrin.

Resting Phase After infiltration, 30 to 60 minutes was allotted to allow the solution to diffuse evenly between the fat lobules and to optimize the efficacy of epinephrine and lidocaine. In cases in which the firm and swollen (tumescent) state of the tissue had significantly faded, re-infiltration was performed.

Aspiration Phase The patient was asked to take the preferred position for the surgeon. After each change of position, the target area was cleaned with povidone iodine. Multiple 3- to 4-mm incisions were made to reach the fat from multiple directions. The aspiration cannulas used were predominantly the Klein and Capistrano cannulas HK Surgical, San Clemente, CA, with a diameter up to 2.2 mm. From 2001, powered cannulas with a diameter up to 3 mm were used in all body areas except the face and neck. Exact measurement was made of the amount of tumescent solution infiltrated. The total aspirate, consisting of blood-tinged infranatant solution and supernatant fat, was measured after allowing the collection canisters to stand for a minimum of 30 minutes, which ensured separation of the two layers.

Postoperative Phase Fucidin cream was applied at the incision sites. Absorbent pads were covered first with an elastic garment and then the patient's clothing. Showering was permitted the following morning. Compression was advised day and night for approximately 2 weeks. Postoperative visits were scheduled at 4 months after the procedure and on demand. Patients received the private telephone numbers of the doctor who performed the procedure and of a nurse familiar with the case history. In selected cases, extra visits were scheduled. It was advised to resume physical and sporting activities gradually.

Results

During 1996 to 2008, the number of procedures performed was 3,240, involving treatment of 7,511 body areas (Table 2). The male to female ratio was 1:9, and the average age was 43 (range 16–81). Table 3 shows an overview of operating data collected on all 3,240 cases. These data also include small special indications such as sacral area, ankle fat pads, lipoma, touch-ups, and corrections. A touch-up is defined as a procedure to improve results in a patient treated by the same surgeon in a former session. A correction is defined as a procedure to improve

TABLE 2. Distribution of 7,511 Body Areas Treated

Body Area	*Treated,* n
Neck	243
Arms	65
Female breast	169
Male breast	37
Stomach	291
Upper abdomen	844
Lower abdomen	1,187
Pubis	31
Hips or love handles	957
Waist	276
Scapular roles	199
Infra-axillary	164
Buttocks	467
Outer thigh	1,004
Inner thigh	666
Inner knee	575
Anterior thigh	94
Posterior thigh	34
Lower legs	68
Others (e.g., lipoma, sacral, buffalo hump)	48
Touch-up	57
Correction	35

TABLE 3. Operating Data in 3,240 Cases

	Average	*Minimum*	*Maximum*
Areas treated, *n*	2.3	1	6
Tumescent solution infiltrated, mL	3,698	10	14,300
Lidocaine dosage, mg/kg of body weight	33.6	0.5	86
Total aspirate, mL	2,008	4	7,950
Supernatant fat, mL	1,489	3	6,600

results of a procedure performed by a doctor from another clinic. The touch-up rate was 0.08%, which did not significantly change over the years.

The average amount of tumescent solution infiltrated was 3,689 mL (range 10–14,300 mL), and the average lidocaine dosage was 33.6 mg/kg of body weight (ranging from 0.5 to 86 mg/kg). In one case, an unintended dosage of 86 mg/kg was infused, but careful monitoring of this patient showed no signs of lidocaine toxicity. The total average amount of aspirate was 2,008 mL (range 4–7,950 mL), with an average amount of supernatant fat of 1,489 mL (range 3–6,600 mL).

Safety

Table 4 shows an overview of potential complications that could occur and the incidence of these complications encountered during our study. No deaths occurred, there were no complications that needed hospitalization, and no legal claims were initiated, although there were a number of complications that needed further action. One patient developed overall malaise, nausea, and a rash within 12 hours after the operation. Her blood samples showed the level of serum lidocaine to be below toxicity levels, and later she was diagnosed as having an allergic reaction to the penicillin antibiotic used. Another patient mentioned minor edema of the hands and face after liposuction of the flanks.

TABLE 4. Complications and Reactions that Needed Action

Complication	*N*	*Action*	*Permanent Damage*
Death	0		
Deep infection	0		
Bowel perforation	0		
Pulmonary embolism	0		
Deep venous thrombosis	0		
Fat embolism	0		
Fluid overload	0		
Necrotizing fasciitis	0		
Generalized edema	1	Furosemide per os	None
Lidocaine toxicity	0		
Allergic reaction to penicillin	1	Stop penicillin	None
Extensive skin necrosis	0		
Small skin necrosis (<5 cm)	2	Wound care	Scar
Extensive hematoma	2	Drainage and spontaneous resorption	None
Seroma	0		
Nerve damage	0		
Panniculitis-like reaction	2	Antibiotics and prednisone	None
Bladder retention	1	Catheterization	None
Permanent lymphedema	0		

per os, by mouth.

Because she had experienced generalized edema in the past (which was not mentioned during consultation) she took oral furosemide, and the symptoms disappeared the next day. A patient whose outer thigh and hip had been treated contacted the clinic because of lower abdominal pain. She was diagnosed with urinary retention, and a single catheterization eliminated the pain. A patient had a bulla formation with a diameter of 4 cm in the area of pain in the upper abdominal region, which left a scar 4 cm in

length. The recovery was unproblematic, and the scar did not disturb the patient. Another patient contacted the doctor 10 hours after the operation because of painful swelling in the knee. The pain was caused by a hematoma, which was successfully and painlessly treated by aspiration after infiltration of local anesthesia. One patient contacted the clinic 2 days after liposuction of the breast, which had resulted in the formation of a hematoma. The hematoma was absorbed over time, leaving a slight discoloration 1 year after treatment. A female patient developed a blister after liposuction of the breast. Wound care was applied, and the wound healed with minimal scarring that did not disturb the patient. Two patients developed redness, swelling, and tenderness in the inner knee area after extensive liposuction performed in that region. One of these patients had Dercum's disease; the other had lipedema. The panniculitis-like reaction, without systemic symptoms, was treated with a combination of antibiotics and prednisone. Both patients healed well, without noticeable consequences. Minor unwanted side effects occurred, but none of these troubled any of the patients (Table 5).

TABLE 5. List of Unwanted Side Effects as Seen in Our Series that Healed without Need for Further Treatment and Were of No Concern to the Patient

Side Effect	*Remarks or Measures*
Hyperpigmented incision sites	Fade over time. Since the use of powered cannulas, no concern because of limited number of incisions
Hypopigmented incision sites	Cover make-up
Hypertrophic incision sites	Silicone gel
Erythema after liposuction	Not seen since supertumescence and triport cannula
Small surface irregularities	Touch-up
Nausea due to antibiotics	Stop or replace antibiotics
Small local infected incision sites	Follow-up
Prolonged edema	Furosemide in 1 patient
Longer recovery than expected	Follow-up
Vasovagal reaction	Preventive instruction
More postoperative pain than expected	Follow-up
Fever (1 day postoperative)	Follow-up
Irregular menstrual cycle	Temporary

Discussion

Underreporting in the medical literature of complications encountered during and after an operative procedure could lead to erroneous conclusions being reached concerning the safety of the procedure. To allow accurate assessment of the safety of liposuction using exclusively TLA, we have documented all 3,240 liposuction cases and report herein any complications that occurred.

After the introduction of the promising technique of liposuction in the 1970s, serious complications and disastrous cosmetic results were common. The major breakthroughs that eliminated these serious complications were the development of the so-called tumescent technique by the dermatologist Jeffrey Klein and the replacement of large-diameter aspiration cannulas by microcannulas. With these advances, liposuction could be performed under local anesthesia, which eliminated the risks of general anesthesia; cosmetic results were improved considerably, and the overall risk was minimal. In our series of 3,240 procedures, no serious infections after tumescent liposuction were observed. An explanation for the extremely low postoperative infection rate could be due to a combination of the following factors. First, patients were prescribed antibiotics for an extended period of 7 days. Second, the incisions were left open for sufficient time to allow effective postoperative drainage, which also reduces the chance of contamination. The compression garments enhance this drainage. Third, there is a possible antibacterial effect of lidocaine,[18–20] and it has been suggested that the presence of sodium bicarbonate in the tumescent solution could enhance the antibacterial

effect of lidocaine,[21] although others believe that the solution used in TLA does not significantly inhibit the growth of commonly encountered bacteria.[22] Fourth, because the only entries are the incision sites, and open surgery is not involved, the risk of contamination by the surroundings is reduced. Fifth, any introduction of microorganisms would be limited to the target subcutaneous fat layer; the deep fascia is not penetrated. Sixth, the use of sharp infiltration and, most importantly, sterile suction cannulas reduces contamination risks associated with the introduction of surgical instruments. Seventh, the procedure was performed in a well-ordered clinical setting, where risks for human and procedural mistakes are minimized. Accreditation of the clinic has contributed to this high-quality structure.

Of all the above-mentioned explanations for the low risk of infections, postoperative drainage is probably of greatest importance. The prophylactic use of antibiotics probably also contributes, but the questionable cost–benefit ratio and the contribution to the development of antibiotic resistance are arguments that could be used against the use of antibiotics. The possible antibacterial effect of lidocaine remains unclear.

Although in general surgery there is a relationship between operation time and infection risk, this liposuction procedure, with minimal incisions, shows only a low risk for infections despite the long operating time, as long as the technique described herein is followed.

A potential risk specifically related to liposuction using TLA is lidocaine toxicity. Selecting unmedicated, healthy young women as a reference group, Klein demonstrated that a dose of 35 mg of lidocaine per kg of bodyweight was safe.[23] Later, a dose of 55 mg/kg was also proven to be safe for this group.[24] For those outside the reference group, such as patients with drug interference with enzymes cytochrome P4501A2 or P4503A4 or those older in age or with specific diseases, the maximum dose should be lowered accordingly. This is necessary to ensure that the threshold for minor lidocaine toxicity, manifested by symptoms of nausea or dizziness, is not reached. There have been no published cases of serious lidocaine toxicity when the guidelines for exclusive TLA were strictly followed, but even in the case of unforeseen elevation of serum lidocaine levels, it seems virtually impossible to reach life-threatening toxic doses when TLA is used exclusively. The effect of a combination of several different factors may explain this. Two major factors are considered to be the lipophility of lidocaine and the vasoconstrictive effect of epinephrine. These effects lower and delay the absorption of lidocaine. All published cases of serious lidocaine toxicity were a result of the guidelines being violated, toxicity resulting mainly from interference with drugs used by the patient, or the use of general anesthesia or intravenous sedation.

A recent publication[25] describes a series of 72 cases of serious complications that occurred after liposuction procedures. It states that, in 17 cases, four of which resulted in death, true tumescent anesthesia was used, but no data were provided regarding the techniques used, and it was not stated whether the correct guidelines had been followed. Based on this article, therefore, it cannot be concluded that there is any evidence that performing liposuction using exclusively TLA according to the guidelines has led to these serious complications or deaths.

All other severe complications, even deaths, that are described in the literature, occurred mainly in combination with general anesthesia. An explanation for the virtual absence of risk of bowel perforation when TLA is used can be explained as follows. Infiltration of an abundant volume of tumescent solution enlarges the subcutaneous tissue, creating a safety margin to deep structures. Also, a patient would react promptly should deep structures be approached, which would not occur during sedation or general anesthesia. Potential herniation of the abdominal wall should be excluded preoperatively.

In our series of 3,240 liposuction procedures using exclusively TLA, no serious complications occurred.

This supports the data from literature in retrospective[26,27] and prospective data.[28] Careful monitoring of the patient is essential, and during the 24 hours after the procedure, contact with the patient is always made by telephone to detect at an early stage any complications that may develop.

Our data prove that this technique of liposuction offers most benefits with low risk of complications for our patients.

Conclusions

Because no deaths, hospitalizations, serious complications, or legal claims occurred after liposuction using exclusively TLA in our series of 3,240 consecutive patients, provided that the existing guidelines are meticulously followed, the procedure is safe. In cases reported in the literature in which serious complications or deaths have occurred, the guidelines for liposuction using TLA were not followed. In most of these cases, the reported complications resulted from the liposuction procedure using TLA being combined with co-medication or other intravenous fluid management procedures. To minimize the risk of complications, we recommend that the guidelines for liposuction using exclusively TLA should be strictly followed. Alternative guidelines, which allow the option of employing additional other types of anesthesia, such as general anesthesia, deep intravenous sedation, and lumbar anesthesia, should not be followed.

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