

# Tumescent Anesthesia for Dermatological Procedures Other Than Liposuction

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## Abstract

**Context:** Tumescent local anesthesia is a form of local anesthesia, which is a technique in which a dilute local anesthetic solution is injected into the subcutaneous tissue until it becomes firm and tense. Originally developed to facilitate liposuction, the use of tumescent anesthesia has expanded to other dermatological and plastic surgery procedures, as well as to other disciplines, including endocrine and vascular surgeries. For infiltration local anesthesia, the conventional dosage of lidocaine is up to 4.5 mg/kg, and that with adrenaline is up to 7 mg/kg; however, in liposuction using tumescent anesthesia, the recommended maximum dose of lidocaine with adrenaline is up to 55 mg/kg. There are several important pharmacological, pharmacokinetic, and pharmacodynamic factors that need to be considered in the administration of tumescent anesthesia leading to considerable interdisciplinary differences of opinion with respect to the maximum dose of local anesthetic permissible. Although several studies and publications have studied these issues in liposuction extensively, the role of tumescent anesthesia in other indications has not been reviewed adequately. **Aims and Objectives:** The aim of this study was to discuss the science behind tumescent anesthesia, its applications, and safety considerations in different dermatological procedures other than liposuction. **Materials and Methods:** For this review, a systematic literature search in PubMed, Embase, Web of Science, Cochrane Library, Central, Emcare, Academic Search Premier, and ScienceDirect was conducted for safety studies on tumescent anesthesia. **Conclusion:** Tumescent anesthesia is generally very well accepted by patients and is relatively safe at the recommended doses. Nonetheless, one must be vigilant about the signs and symptoms of LAST, as they may not manifest until several hours after the procedure. Lipid emulsion therapy should be readily available and could prove life-saving in such situations.

**Keywords:** Dermatological surgery, lignocaine, safety, tumescent anesthesia, tumescent liposuction

**Key Messages:** Tumescent anesthesia has many applications in dermatological surgery other than liposuction. Although very well accepted by patients and relatively safe at the recommended doses, one must be vigilant about the signs and symptoms of LAST. Lipid emulsion therapy should be readily available and could prove life-saving in such situations.

## INTRODUCTION

Tumescent local anesthesia is a form of local anesthesia, which has been used for several dermatological procedures, particularly liposuction. It is a technique in which a dilute local anesthetic solution is injected into the subcutaneous tissue, until it becomes firm and tense. The word “Tumescent” means Tumid—Firm and Swollen.

In 1985, Dr. Jeffrey A. Klein,<sup>[1]</sup> a dermatologist in California, revolutionized liposuction surgery when he developed the tumescent technique, which permits liposuction totally by local anesthesia and with minimal surgical blood loss. For infiltration local anesthesia, the conventional dosage of lidocaine is up to 4.5 mg/kg, and that with adrenaline

is up to 7 mg/kg; however, in liposuction using tumescent anesthesia, the recommended maximum dose of lidocaine with adrenaline is up to 55 mg/kg.<sup>[2]</sup>

Originally developed to facilitate liposuction, the use of tumescent anesthesia has expanded to other dermatological and plastic surgery procedures, as well as to other disciplines, including endocrine and vascular surgeries. There are several important pharmacological,

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pharmacokinetic, and pharmacodynamic factors that need to be considered in the administration of tumescent anesthesia leading to considerable interdisciplinary differences of opinion with respect to the maximum dose of local anesthetic permissible. Although generally well tolerated, the technique is not without safety risks, given the high volumes of local anesthetic frequently administered. Although several studies and publications have studied these issues in liposuction extensively, the role of tumescent anesthesia in other indications has not been reviewed adequately.

This article will discuss the science behind tumescent anesthesia, its applications, and safety considerations, in different dermatosurgical procedures other than liposuction.

## MATERIALS AND METHODS

For this review, a systematic literature search in PubMed, Embase, Web of Science, Cochrane Library, Central, Emcare, Academic Search Premier, and ScienceDirect was conducted for safety studies on Tumescent anesthesia. The search keywords were tumescent anesthesia, tumescent liposuction, dermatosurgery, lignocaine, and safety.

### Tumescent anesthesia: general principles

#### Standard tumescent solution—*anesthetic*

Lidocaine is safe for use in tumescent local anesthesia and is the standard drug used. The pharmacokinetics of prilocaine are similar to lidocaine and its use has been recommended as it is metabolized in the kidney, unlike lignocaine which is metabolized in liver. However, one of the metabolites of prilocaine, O-toluidine, can promote the development of methemoglobinemia. Experience with this drug is limited and hence not used as widely.<sup>[3-5]</sup> It has also been suggested that a combination of lidocaine and prilocaine may reduce the risk of toxicity from either drug and might be favorable in cases where a large volume of tumescent local anesthesia is needed.<sup>[6]</sup> A combination of prilocaine (maximum dosage 4mg/kg) and ropivacaine (maximum dosage 2 mg/kg) diluted with original Ringer's solution with epinephrine (1:1,000,000) injected slowly (speed between 30 mL/h and 1500 mL/h depending on the location) and automatically via subcutaneous infusion anesthesia (SIA) has been proven to be safe, long lasting, and comfortable even for children and very sensitive patients.<sup>[7]</sup> Use of bupivacaine is not recommended for this use due to greater risk of cardiotoxicity and limited experience of its use.

The formulation of the solution, called Klein Solution, is the cornerstone of the success of tumescent anesthesia. The local anesthetic–epinephrine–saline mixture, also called as Klein's solution, is prepared by adding a 50-cc bottle of plain 1% lidocaine and 1 cc vial of 1:1000 epinephrine to a standard 1-L bag of sodium chloride

solution. The resulting mixture contains 0.05% lidocaine and 1:1,000,000 epinephrine. Lidocaine by itself and with epinephrine is highly acidic and hence causes stinging during infiltration. Hence, about 10 mEq of sodium bicarbonate is added to 1 L of tumescent solution to alkalize the solution, increasing the percentage of local anesthetic in the nonionized form, which promotes its transit into cells and speeds the onset of analgesia and also reduces stinging. Higher concentrations of lidocaine are often needed in certain areas of the body with more fibrous tissue such as upper abdomen and flanks.<sup>[8]</sup>

### Pharmacology and safety considerations

These have been widely studied and documented in liposuction. It has generally been believed that the maximum recommended dose of lidocaine without epinephrine is 4.5 mg/kg and with epinephrine is 7 mg/kg for infiltration anesthesia. However, the dosage used in liposuction far exceeds this dosage. Lidocaine with epinephrine in doses between 35 and 55 mg/kg are routinely used in tumescent anesthesia for liposuction. These are associated with an excellent safety track record.<sup>[5,8,9]</sup>

American Academy of Dermatology (AAD) guidelines recommend a maximum dose of 55 mg/kg lidocaine with epinephrine to be safe for tumescent anesthesia for liposuction, in patients weighing 43.6–81.8 kg.<sup>[10]</sup> These guidelines are in part based on a study published in 1996 by Ostad *et al.* in which a group of 10 patients underwent liposuction using tumescent anesthesia with a mean lidocaine dose of 55 mg/kg and none experienced peak serum lidocaine concentrations greater than 3.6 mcg/mL (toxic levels are generally considered to be >5 mcg/mL). Another study to establish well-tolerated lidocaine doses for tumescent anesthesia by Klein and Jeske<sup>[11]</sup> determined a maximum well-tolerated lidocaine dose of 28 mg/kg if no liposuction was performed and 45 mg/kg if liposuction was performed. In general, men have lower body fat than females and are thus more susceptible to local anesthetic toxicity. Hence, it is recommended that the maximum allowable dose should be reduced by about 10% for males.<sup>[12]</sup>

Several mechanisms have been offered as to the safety of these very high doses of lidocaine in tumescent anesthesia:<sup>[13-15]</sup>

- Lidocaine is highly soluble in fat resulting in a prolonged slow absorption into the systemic circulation.
- Part of the administered lidocaine is removed along with the sucked out fat. Roughly 7.5%–30% of the administered lidocaine dose is removed with the aspirated fat during the procedure.
- Because of very high dilutions, sufficient concentrations are not reached to achieve the necessary gradient for absorption
- Epinephrine induced vasoconstriction further reduces this absorption.

Likewise the doses of epinephrine should also be carefully calculated. The dose of epinephrine in local anesthesia should not exceed 0.07 mg/kg in any patient to limit the incidence of significant systemic effects.<sup>[16]</sup> Epinephrine is unstable in alkalized lidocaine solutions and hence concentrations decrease substantially over 24h.<sup>[17]</sup> Epinephrine is known to degrade spontaneously in a neutral solution (pH 7–7.4) with a half-life of about 10–14 days. This is important as tumescent solutions are buffered to avoid stinging as mentioned above. Therefore tumescent anesthetic solutions should be freshly mixed on the day of surgery.<sup>[12]</sup>

### Indications of tumescent anesthesia

The advantages of tumescent anesthesia such as outpatient administration, prolonged anesthesia, profound hemostasis reducing the blood loss by vasoconstriction, extended postoperative analgesia, reduced postoperative pain, minimal downtime and absence of need for hospitalization are suitable for a number of dermatosurgical, plastic-surgical, and other surgical procedures as mentioned in the table below.

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#### Applications of tumescent anesthesia

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##### A. Dermatosurgery indications:

- Hair transplant
- Facial procedures such as full face laser resurfacing, dermabrasion, subcision for acne scarring, microneedle radiofrequency, blepharoplasties, face lifts
- Serial excision of birthmarks, scars
- Dermatologic surgeries such as shave biopsy, lipoma excision, Moh's micrographic surgery
- Vitiligo surgery
- Anesthesia for zoster dermatitis
- Axillary hyperhidrosis

##### B. Plastic surgery indications:

- Liposuction
- Surgery for burns, scars
- Breast surgeries such as breast augmentation, breast reduction, and mastectomy
- Mini-abdominoplasty, brachioplasty, and medial thigh lifts

##### C. Other surgical indications:

- Endovenous laser therapy
  - Hand surgeries
  - Repair of inguinal hernia<sup>[18]</sup>
  - Management of pilonidal cysts<sup>[19]</sup>
  - Endoscopic thyroid and parathyroid surgeries<sup>[20]</sup>
  - Lymph node dissection<sup>[21,22]</sup>
- 

As can be seen from the above table, these procedures have the following features in common:

1. They all involve large areas or multiple lesions
2. They need prolonged duration of anesthesia
3. Infiltration anesthesia would be needed in far excess of the upper limit of lignocaine
4. Multiple punctures would be painful and hence single or minimal number of entries is preferable

5. Many of these lesions /areas may bleed and vasoconstriction would therefore be necessary for smooth surgery.

As clear from the above-cited mechanisms, tumescent anesthesia is helpful in satisfying all these requirements.

However, it is important to understand that tumescent anesthesia is not routinely taught in residency programs of dermatology. Although the process may appear simple and easy, complex pharmacological and anatomical considerations are necessary and hence, a practicing dermatologist should specifically learn the technique in the hands of a trained surgeon before using this technique. It is important to understand that the process takes time, cannot be hurried and patient comfort and safety are of utmost consideration.

### Hair transplant

Bilevel tumescent anesthetic infiltration technique (deep and superficial planes) is a highly useful method of anesthesia for hair transplant harvesting and transplanting.<sup>[23]</sup>

In Hair transplantation, tumescence is used in two levels:

- a) Upper level in papillary dermis
- b) Subcutis

The advantages of tumescent anesthesia in hair transplantation include -

In donor area

- Upper level: Increasing the rigidity of donor area which helps to decrease follicular transection during the harvest. This is achieved by the superficial tumescence. This superficial tumescence also causes blockage of fine nerve fibers in papillary dermis and the small blood vessels.
- Deeper tumescence at Subcutis and below acts by increasing the distance between the vascular plane and the plane of dissection, that is, follicles residing in upper fat, thus reducing the chances of injury to nerves and large blood vessels.
- Tumescence reduces the total amount of anesthetic required.
- Increasing the duration of action and hence providing pain relief

In recipient area, it results in prolonged action, vasoconstriction, and thereby allows dense packing of hair follicles and prevents popping.

However, tumescence over recipient area has one disadvantage that it contributes to post-operative swelling.

Role of Tumescence in follicular unit excision method (FUE) is more controversial. Here superficial tumescence can change the direction of emerging hair and this may increase the chances of transection. Hence, many authors have argued against this. However, deeper

tumescence which is below the level of hair follicle can help in prolonging the duration of anesthesia and thereby reducing the amount of lidocaine used. This is particularly relevant in FUE mega sessions.<sup>[24]</sup>

Tumescent anesthesia has been used in body hair transplantation also. As large areas on chest are often used for donor extraction, neither infiltration nor nerve blocks are useful. Tumescent anesthesia helps in anesthetizing large areas with minimal amount of lidocaine. It also produces the necessary turgor which facilitates extraction.<sup>[25]</sup>

### Full face resurfacing

Resurfacing involves use of either dermabrasion or an ablative laser such as carbon dioxide (CO<sub>2</sub>) laser for the removal of the entire epidermis and upper portion of the dermis in order to stimulate collagen production. Due to the stimulation of dermal nerve fibers, the patient experiences significant pain during the procedure and also post-procedure. TA has been used successfully in anesthetizing the face for facial resurfacing procedures, with the added advantage of increased skin turgor, which stretches wrinkles for maximal exposure for the laser beam as well as provides added skin hydration. The postoperative period is less painful as the burning sensation is minimized by the remaining anesthesia.

Introduction of anesthetic fluid into the subcutaneous plane through infiltration cannulae adits (Tulip



**Figure 1:** Infiltrator insertion sites. Infiltration is made via entry sites to anesthetize the face<sup>[26]</sup>

- Forehead, temporal area, medial nose infiltrated through an introduction site in the mid-anterior hairline/forehead junction
- Lateral nose, chin and lips infiltrated through an introduction site just under the lobule cheek
- Infiltration through introduction points just lateral to the lips

infiltration) at multiple sites is used, after application of topical anesthetic at entry points, as shown in Figure 1.<sup>[26]</sup>

Using this technique, the entire face can be anesthetized using 300–400cc of anesthetic solution. The formulation of 0.08% final concentration of lidocaine is generally used for facial procedures.

Another technique of administering anesthesia in laser resurfacing is a combination of nerve blocks and TA, or just TA in the following manner<sup>[27]</sup> -

- A “horseshoe” tumescent block is performed on each side of the face beginning at the temporal hairline and extending sequentially to the preauricular area, jaw, and chin with a mixture of 0.2% lidocaine and 1:1,000,000 epinephrine.
- Local nerve blocks are then applied to the supraorbital, supratrochlear, infratrochlear, and mental nerves with 1% lidocaine and 1:100,000 epinephrine or alternatively, a subcutaneous block just above the eyebrow using the same TA (0.2% lidocaine, 1:1,000,000 epinephrine) can be given.
- Then the upper and lower eyelids are injected with TA from the lateral canthus to the inner canthus. This injection is kept within the dermis (above the orbicularis oculi) to minimize ecchymosis.
- The nose is then injected with TA first in the nasofacial sulcus below the medial canthus, inferiorly at the columella, and then a small amount of TA in the area of the external nasal branch of the anterior ethmoidal nerve.
- The face is then tested for sensation using a sharp needle and the remaining “hot spots” (usually the cheek, lateral to the oral commissure) are then infiltrated with TA.

The advantages of this method are that no infusion pumps are necessary and post-anesthesia recovery is immediate with the anesthetic effect lasting for many hours postoperatively.<sup>[28]</sup> The only disadvantages of TA are that the procedure time is lengthened (as compared to facial laser resurfacing performed under general anesthesia or intravenous sedation) and multiple injection punctures.<sup>[27]</sup>

Yet another method used in laser resurfacing is the use of nerve blocks in the central part of the face and TA for the lateral face and cheeks, with a TA solution consisting 0.2% lidocaine and 1:1,000,000 epinephrine.<sup>[26]</sup>

### Other facial procedures

Tumescent anesthesia can also be administered prior to other facial procedures such as dermabrasion, subcision for acne scarring, microneedle radiofrequency, blepharoplasties, and facelifts.<sup>[29,30]</sup> However, one of the disadvantages of using TA during dermabrasion is that the character and feel of the skin becomes different after TA. Also TA interferes with proper determination of the depth of the dermis based on the fine pinpoint and course bleeding landmarks due to its vasoconstrictive effect.<sup>[31]</sup>



For facelift procedures the anesthesia provides an excellent plane, allowing for safe and bloodless dissection.

A combined single treatment of rolling acne scars using trichloroacetic acid 20% chemical peel, subcision, and fractional CO<sub>2</sub> laser resurfacing along with tumescent anesthesia has been studied and found to be safe and effective in the treatment of rolling acne scars.<sup>[30]</sup>

- Tumescent anesthesia is used in various dermatologic surgeries such as shave biopsy, lipomas, serial excisions of birthmarks, Moh's micrographic surgical excisions. This technique expands the subdermal space between the perichondrium and overlying soft tissue to allow easier dissection and excisions.<sup>[32,33]</sup>
- Harvesting of the graft from the donor area in vitiligo surgery can also be done by using tumescent anesthesia while harvesting large areas of donor skin for split thin skin grafting. In particular, mega vitiligo surgery sessions (150–400 cm<sup>2</sup>) or gega sessions (>400 cm<sup>2</sup>) either by punch grafting or split skin grafting have been described and tumescent anesthesia would be particularly useful in these situations.<sup>[34]</sup> However, with epidermal cell suspension methods slowly replacing split skin grafts, this indication is used infrequently.
- The use of TA has been described in the surgical treatment of burns and postburn sequelae in pediatric patients.<sup>[35]</sup>
- Anesthesia for Zoster dermatitis:

Tumescent infiltration of corticosteroids, lignocaine, and adrenaline into dermatomes of acute herpetic pain or postherpetic neuralgia was described in 1998.<sup>[36]</sup> In a pilot study conducted by Stephen E. Chiarello, a total of 26 patients suffering from acute herpetic neuralgia and postherpetic neuralgia received an injection consisting of 0.05% lidocaine with 1:1000000 epinephrine in normal saline solution, with 60-80 mg of triamcinolone acetonide into the dermatomal area of their pain sensation. The solution was injected with a 20-gauge lumbar puncture needle, using an infusion pump or a 10-mL disposable infusion syringe attached to an intravenous bag into the upper dermis, as well as into the deeper reticular dermis and subcutaneous tissue including fat, until the entire affected area became tumescent or hardened as one would achieve with tumescent anesthesia for liposuction. The amount of anesthetic solution injected depended on the extent of the area affected and ranged from 100 to 1000 mL. Even though statistical analysis was not done in this study, the results were promising.

### ***Tumescent suction curettage for axillary hyperhidrosis***

Curettage of axillary sweat glands using suction cannula, after infiltration of tumescent local anesthesia with 100–200 mL of lidocaine 0.25% with epinephrine, is an effective and safe treatment for axillary hyperhidrosis.<sup>[37]</sup> Although long-term recurrence may occur due to reinnervation, it is

better than botulinum neurotoxin injections for axillary hyperhidrosis in terms of cost-effectiveness and the need for a single surgical sitting. It is especially preferred in patients with high pre-operative sweat rates.

### ***Breast***

Tumescent anesthesia can be used for breast augmentation, breast reduction, and mastectomy.<sup>[38]</sup> The infiltrated solution allows for a correct plane under the mammary gland and in the axillary area with easy undermining and improved hemostasis.<sup>[39]</sup> Epinephrine is best avoided in these surgeries due to the risk of flap necrosis.

### ***Endovenous laser therapy***

Endovenous laser therapy was approved by the Food and Drug Administration in 2002 for the treatment of varicose veins. Previously popularized by vascular surgeons, it is now performed by interventional radiologists, plastic surgeons, and dermatologists too. In contrast to liposuction, where tumescence is injected into a relatively avascular space, during EVLT, it is injected circumferentially around the vein using ultrasound guidance. Tumescent solution not only provides analgesia but also aids in dissipating heat from the laser to minimize injury to surrounding structures. In addition, it facilitates mechanical compression of the vein thereby helping contact of the laser tip with the vein.<sup>[40]</sup> There is no groin incision and therefore lower rates of infection, a more rapid turnover and earlier discharge.

In EVLT, epinephrine is sometimes omitted from the tumescent mixture due to an increased concern of systemic absorption and resultant tachycardia and hypertension, as the solution is injected in the perivascular space. The absence of this additive allows more local anesthetic to be absorbed into the systemic circulation, increasing the chances of LAST.

After tumescent infiltration for liposuction, serum lidocaine concentrations peak between 12 and 16 h after injection (peak serum levels following intravenous injection  $\approx$  20 to 30 min after injection).<sup>[11,13]</sup> When tumescent lidocaine without epinephrine is used for endovenous laser therapy, peak serum lidocaine concentrations are observed much earlier, between 1 and 2 h after injection.<sup>[40]</sup>

The volume of tumescence used depends on the length of the vein to be treated; a rule of thumb is approximately 10 mL of tumescence per 1 cm vein.<sup>[41]</sup> Average volumes that have been reported are between 250 and 655 mL, with total lidocaine doses ranging from 3 to 10 mg/kg.<sup>[40]</sup>

### ***Complications in tumescent anesthesia***

Although generally safe, the use of tumescent anesthesia carries a risk of local anesthetic systemic toxicity (LAST). Several cases of fatalities have been reported.<sup>[11,42-44]</sup> Hence the method needs proper pharmacological knowledge, and diligence during administration. The reported adverse

events associated with tumescent lidocaine anesthesia have been the result of clinician error, such as inadvertent IV delivery of tumescent solution, miscommunication leading to excessive lidocaine in the tumescent lidocaine solution, unawareness of drug interactions that reduce lidocaine metabolism by impairing cytochrome P450 1A2 and 3A4, and ad libitum formulations of tumescent solutions using bupivacaine, mepivacaine, or triamcinolone.<sup>[45,46]</sup>

It is important to understand that the safety of the procedure is increased only if it is done totally under local anesthesia. Possibility of risks increase if there is additional intravenous or general anesthesia.

Most complications after TA are due to the side effects of lignocaine. Complications from epinephrine added to local anesthesia at the above-mentioned doses are generally rare. However, sensitivity to the drug varies, and symptoms of palpitations and anxiety may occur in some patients. TA should therefore be given cautiously to those with sympathetic overactivity. Oral clonidine has been shown to prevent the signs of sympathetic overactivity. Patients with hypertension, ischemia heart disease, arrhythmias, and those on betablockers need prior clearance by a physician.

The risk of LAST increases in patients with impaired liver function, conditions reducing the hepatic blood supply and in patients with renal failure. Drugs that interfere with the cytochrome P450 3A4 and 1A2 isoenzymes such as betablockers, diazepam, cimetidine, sertraline, diltiazem, phenytoin, and procainamide also increase the risk of LAST, by impairing lidocaine metabolism.<sup>[11,15,47-50]</sup>

Other factors that increase the risk of local anesthetic toxicity include the use of higher concentrations of local anesthetic, rapid injection, and perivascular injection. Recently, it has been recommended that lidocaine concentrations for tumescent anesthesia be lowered to between 0.01 and 0.05%,<sup>[51]</sup> Slow administration of higher dilutions of local anesthetic decreases the risk of local anesthetic systemic toxicity.<sup>[13,52]</sup>

In settings wherein tumescent anesthesia is used, the risk for local anesthetic systemic toxicity should be recognized;

there is a well-documented association of serum level of lidocaine and the symptoms as shown in the table below.

The generally accepted threshold level for lidocaine toxicity is 5 mcg/mL.<sup>[53]</sup> However, the level at which symptoms manifest varies with each patient. Subjective toxic symptoms are seen usually at serum concentrations between 3 and 6 mcg/mL.<sup>[51]</sup>

Objective toxicity occurs at serum concentrations between 5 and 9 mcg/mL.

| Serum concentrations |                     | Symptoms  |
|----------------------|---------------------|---|
| 3–6 mcg/mL           | Subjective toxicity | Lightheadedness, restlessness, drowsiness, tinnitus, impaired vision, digital paresthesia and circumoral numbness |
| 5–9 mcg/mL           | Objective toxicity  | Nausea, vomiting, tremors, confusion, excitement, psychosis and muscular fasciculations                           |
| >10 mcg/mL           |                     | Cardiac excitation followed by cardiac depression—bradycardia, asystole, seizures, and coma                       |
| >20 mcg/mL           |                     | Respiratory arrest  |
| >26 mcg/mL           |                     | Cardiac arrest  |

Many patients have atypical presentation and this variability contributes to delay in diagnosis.

Lignocaine toxicity can be neutralized by lipid rescue which was first described by Weinberg *et al.*<sup>[54]</sup> Lipid emulsion is believed to work by sequestering the highly lipophilic local anesthetic molecules, removing them from their active sites in the cardiac and central nervous systems.<sup>[55]</sup>

ARSA Guidelines (American Society of Regional Anesthesia) for treatment of local anesthetic systemic toxicity have been mentioned in Table 1.<sup>[56]</sup>

Several independent studies have found that peak plasma concentrations of lidocaine only occur on average between 8 and 18 h after tumescent infiltration.<sup>[10,13,29,57-62]</sup>

This implies peak plasma levels will probably not occur in the operating room where the patient is closely monitored but rather following the usual time for discharge. This is

| Supportive care     | Ventilate with 100% oxygen, protect the airway   |
|---------------------|--|
| Seizure suppression | Benzodiazepine preferred   |
| Treat arrhythmias   | As per advanced cardiac life support guidelines; avoid vasopressin, calcium channel blockers, blockers, local anesthetics  |
| Lipid emulsion      | Infuse 20% lipid emulsion <ul style="list-style-type: none"> <li>▪ Bolus 1.5 mL/kg intravenously over 1 min</li> <li>▪ Continuous infusion 0.25 mL/kg/min</li> <li>▪ Repeat bolus once or twice if symptoms persist</li> <li>▪ May increase infusion rate to 0.5 mL/kg/min if blood pressure remains low</li> <li>▪ Continue infusion for at least 10 min after attaining circulatory stability</li> <li>▪ Recommended upper limit: approximately 10 mL/kg lipid emulsion over the first 30 min</li> </ul> |

important as most of the above procedures are daycare procedures and patients often are from distant places. Hence it is probably prudent to inform patients to report any symptoms as mentioned above in the first 18h post-tumescent infiltration.<sup>[57]</sup>

## CONCLUSION

Tumescent anesthesia is generally very well accepted by patients and is relatively safe at the recommended doses. Following practice points are advised for safety while performing procedures under tumescent anesthesia:

- Focused history and physical examination to determine presence of hepatic or renal disease.
- Obtain a thorough medication history to detect Cytochrome P450 inducers or inhibitors
- Calculate the maximum allowable dose of local anesthetic in milligrams.
- Calculate the maximum allowable volume of diluted local anesthetic concentration for infiltration
- Exercise great caution when administering additional local anesthetics for at least 12–18h after tumescent anesthesia

Using a warm (40°C) solution is associated with significantly less discomfort to the patient during infiltration; it also reduces the likelihood of hypothermia.<sup>[63]</sup>

For facial and hair surgery, the patient can be made even more comfortable with the use of a slow infiltration technique and use of simple vibration device, by using counter-stimulation technique. The anesthesia allows for uninterrupted performance of procedures.

There are no reports of death associated with liposuction performed under tumescent local anesthesia by dermatologists, and multiple studies estimate the rate of serious adverse events to be 0.04%–0.16%.<sup>[64–68]</sup>

Nonetheless, one must be vigilant about the signs and symptoms of LAST, as they may not manifest until several hours after the procedure. Lipid emulsion therapy should be readily available and could prove life-saving in such situations.

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## Conflicts of interest

There are no conflicts of interest.

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