

Rule of four: a simple and safe formula for tumescent anesthesia in dermatologic surgical procedures

ABSTRACT

The authors describe a rule to make simpler and easier to use local tumescent anesthetic solution in dermatologic surgical procedures. They report the safety and simplicity of the rule, based on ambulatory surgery practice for over 20 years and an 8year usage of the solution in more than a thousand procedures.

Keywords: tumescent local anesthesia.

INTRODUCTION

The tumescent solution for local anesthesia in liposuction procedures was developed by Klein in 1975. Containing 0.05 to 0.1% lidocaine and 1:1 million adrenaline in 1L of saline, it allowed safe usage of 5 times the recommended maximum of doses of anesthetic with vasoconstrictor, which was 7 mg/kg.¹ Sodium bicarbonate (NaHCO₃) was added to Klein's formula aiming to reduce the pain of infiltration and to increase the antibiotic action of lidocaine.^{2,3}

The tumescent technique has several advantages, such as: it hydrodissects the fat facilitating its removal; it protects the underlying organs bringing up the skin; it reduces bleeding and the possibility of fat embolism by the collapse of the vessels induced by the tumescence and the vasoconstrictor action of epinephrine; and it reduces the possibility of infection, increasing the antibiotic effect of lidocaine with the bicarbonate.

RULE OF FOUR FOR SMALL PROCEDURES

In Brazil, even before the publication of Klein's tumescent technique in 1987, solutions of lidocaine and epinephrine in saline were used in dermatologic surgical procedures, a practice widespread by Ivalo Peres Rosa, coordinator of the Dermatology Department s of Municipal Hospital of São Paulo by that time. The basic objectives were to reduce the bleeding and to protect underlying anatomic structures.

One of most used solutions in dermatologic surgery is:

Lidocaine 2%	10.0 mL
Adrenaline 1:1,000	0.4 mL
NaHCO ₃ 8.4%	4.0 mL
Saline	40.0 mL

The formula for the calculation of the concentrations of the components is: final concentration of the substance (FCS) = concentration of the substance (CS) x volume of the substance (VS) / volume of solution (VSOL).

In the formula above, the final concentration of lidocaine would be: $2 \times 10 / 54,4 = 0.367\%$, and the FCS of adrenaline: $1 / 1,000 \times 0.4 / 54.4 = 0.735 / 100,000$. In this formula, it is difficult to calculate the FCS and the total dose of the components, especially when employing larger or smaller volumes of anesthetic solution. In the classical formula (which already contained three

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Table 1 – Rule of four for anesthetic solution in small dermatological procedures

Substance	Initial Concentration	Quantity	Final Concentration
Lidocaine	2%	4 mL	0.2%
Adrenaline	1:1,000	44 drops (around 0.2 mL)	1:200,000
NaHCO ₃	8,4%	4 mL	0.84%
Saline	0,9%	Qsp 40.0 mL or 31.6 mL	0.71%



Figure 1. Autoclavable beaker of 50 ml with millimeter scale. Note solution at 40 ml.

numbers 4), we reduced the amount of anesthetic and applied quantities based on the number 4 or its multiples, with the following objectives:

- 1 - To make the solution safer, through the reduction of the concentration of anesthetic, but maintaining its effectiveness.
- 2 - To make it easier to memorize and to prepare the formula
- 3 - To achieve more precise final concentrations of substances.

An autoclavable beaker was used with millimeter scale (Figure 1) in order to overcome the difficulty of measuring 31.6 mL of saline. Four mL of lidocaine 2%, 4 drops of epinephrine 1:1,000, 4 mL of NaHCO₃ 8.4% and saline are

added to the solution, in until the 40 mL line.

The effectiveness of the solution (rule of four) in reducing bleeding, in the anesthetic action and in the stability of blood pressure during and after surgery has been proven in over 1,000 procedures in various body regions. It was used in tumor excisions with direct closure or with flaps, dermabrasion, zit scarring elevation and removal, cryosurgery, after curettage and electrocoagulation, or CO₂ laser vaporization (Figures 2-7) in the scalp, face, arms and legs.

TECHNIQUE

Patients should avoid acetylsalicylic acid, anti-inflammatory drugs, vitamin E and ginkgo biloba. This solution is not used in patients treated with anticoagulants. The blood pressure is measured before, during, at the end of surgery, and 4 hours later.

1 - Numb a small area with lidocaine and epinephrine 1:1,000, using a metal syringe and 30G short needle, and inject up to ¼ of the tube around the lesion to ensure a superficial anesthesia.

2 - Inject the solution in the subcutaneous tissue through a small orifice done with the tip of the n.º.11 scalpel blade, using a blunt tip cannula to prevent accidental intravascular injection, attached to a screw up syringe to cause the desired tumescence.

3 - Wait 15 minutes to reach the appropriate anesthetic effect and vasoconstrictor action.

RESULTS

In all patients there was no significant bleeding nor pain in the intra- or postoperative period, although further anesthesia has been occasionally necessary in some areas, with the solution or with small amounts of lidocaine 2% with epinephrine 1:200,000 (tubes) in more superficial injections.

COMMENTS AND CONCLUSIONS

The rule of four allows the execution of different procedures in different areas of the body with minimal bleeding and no detectable change in blood pressure even in hypertensive patients. It is easy to remember, and it can





be adjusted to the size and site of injury by increasing or decreasing the adrenaline concentrations, without changing much the final amount of anesthetic.

It is crucial to respect the maximum dose of 7 mg/kg body weight of lidocaine combined with epinephrine in adults and 3.5 mg/kg in children. In areas of greater bleeding, it is possible to enhance tumescence by injecting pure saline or adrenaline added to the solution, always in precisely controlled quantities, varying the concentration between 1:50,000 (in small places) and 1:200,000 where there is a greater potential for bleeding. It is also possible to raise or reduce the concentration of adrenaline in the rule of four solution. By adding 8 drops to the solution, you get a concentration of 1:100,000, and with 16 drops, a concentration of 1:50,000.

Forty mL of the rule of four solution are sufficient to realize the vast majority of small procedures, adding to the anesthesia $\frac{1}{4}$ (0.45 mL) to $\frac{1}{2}$ (0.9 mL) tubes of lidocaine 2% with or without epinephrine 1:200,000, injected superficially, or increasing tumescence with pure saline or epinephrine

1:100,000 to 1:200,000, injected into the hypodermis. Always remember to add the amount of anesthetic injected in the superficial anesthesia (1.8 mL = 36 mg of lidocaine 2%) and the solution (40.0 mL = 80 mg).

The tumescent solution cannot be reused because the addition of epinephrine and the elevation of pH by NaHCO_3 reduce the stability of lidocaine. The solution should be prepared at the moment of the procedure.

Elaborating the hemostasia is occasionally necessary by suturing or cauterizing larger caliber vessels. However, this is usually unnecessary if one uses the appropriate concentration of adrenaline and makes up a significant tumescence.

It is prudent to measure blood pressure before infiltrating the solution, even in patients with not referred hypertension.

It is advisable to make a compressive dressing to prevent late bleeding and to review the patient the next day to check possible hematoma, which is uncommon in procedures done with the rule of four. **SCD**



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