The Fate of Lidocaine Infiltrate During Abdominoplasty and a Comparative Study of Absorption of Local Anesthetic in 3 Different Regions: Experimental Studies in a Porcine Model

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**Background:** Plasma lidocaine levels obtained during face lifts, breast surgery, and abdominoplasties showed an unexpectedly low absorption of anesthetics despite the use of doses exceeding the manufacturer’s recommended maximum limit.

**Objective:** With the use of an animal model, we sought to determine the amount of anesthetic lost during an abdominoplasty and the levels of anesthetic absorption in different areas of the body.

**Methods:** In the first part of our study, 10 Duroc-Jersey pigs were infiltrated by using the same technique as for an abdominoplasty—specifically, with 14 mg/kg lidocaine (twice the manufacturer’s recommended dose). Plasma lidocaine levels were determined at seven 15-minute intervals after surgery. After 2 days, abdomens of the same animals were infiltrated as before. An abdominoplasty was performed, and plasma lidocaine levels were obtained at 15-minute intervals during surgery. In a second study, we selected 10 pigs to analyze the absorption of anesthetics in different regions and tissues of the body. The axillary and pectoral regions, the face and neck area, and abdominal fat were each infiltrated with a solution containing 14 mg/kg lidocaine, with 2-day intervals between the infiltration of each region. For each region, samples were obtained at 15-minute intervals to determine plasma lidocaine levels.

**Results:** In the first study, plasma lidocaine levels in the animals that underwent abdominoplasty were 32% less at 15 minutes after infiltration and approximately 50% less at the later time intervals than those in the nonoperated animals. In the second study (without surgery), the rate of total absorption of lidocaine was 5.6 μg in the thorax (under the pectoralis major and in the axilla), 3.5 μg in the face, 3.5 μg in the neck, and 2.8 μg in the abdominal fat tissue.

**Conclusions:** In a porcine model, approximately half the injected lidocaine anesthetic is lost during an abdominoplasty. Without performance of surgery, The abdomen has the lowest rate of absorption of anesthetics, the pectoral region the highest, and the subcutaneous tissues of the face and neck an intermediate rate, all of which were within the safe limits recommended by the manufacturer. (Aesthetic Surg J 2001;21:418-422.)

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Accepted for publication July 17, 2001.

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1084-0761/2001/$35.00 + 0 70/1/119404
Plasma lidocaine levels obtained from patients during face lifts, breast augmentation, breast reduction, and abdominoplasties performed with the patient under local infiltrative anesthesia have shown an unexpectedly low absorption of anesthetics.1-7 These low absorption levels occur because local anesthetics bind to fat and because considerable amounts of anesthetic are lost during the incision, dissection, and removal of tissue. With the use of an animal model, we sought to determine the exact amount of anesthetic lost during an abdominoplasty and the levels of anesthetic absorption in different areas of the body—specifically, the face and neck, the pectoral region, and the abdominal wall—without any surgery.

Pigs were selected because they have considerable adiposity and a metabolism similar to that of human beings. The abdominal wall was chosen for study because performance of a face lift or breast augmentation on pigs comparable to those operations performed on human beings would be impossible.

**The Fate of Lidocaine Infiltrate During Abdominoplasty**

Ten Duroc-Jersey pigs, each weighing 20 to 25 kg, were selected for the study. Each one was cannulized in the femoral vein, and a catheter was placed in the inferior vena cava at the diaphragm level to obtain plasma-level samples. Phenothiazide (0.2 mg/kg) and ketamine (20 mg/kg) were administered intramuscularly as premedication. Anesthetic solutions were prepared with 14 mg/kg lidocaine (double the maximum limit of 7 mg/kg recommended by the manufacturer) diluted in 110 to 150 mL of saline solution with epinephrine 1:1000 to obtain a concentration of 1:400,000. The resulting solution was equivalent to that used when operating on a patient weighing 70 kg (1000 mg lidocaine, 1 mL epinephrine 1:1000 in 450 mL saline solution).

This amount of anesthetic solution was injected in a diffused and radiated manner into the fat tissue of the abdominal wall of every pig. Seven blood samples were taken at 15-minute intervals to measure the total absorption. No surgery was performed. Two days later the same pigs were infiltrated in the same manner. This time, however, an abdominoplasty was performed (dermofat resection of the lower abdomen and dissection of the superior flap, up to the inferior ridge of the thoracic wall) (Figure 1). During the operation, a total of 7 blood samples were taken again at 15-minute intervals as in the first stage, and the samples were sent to a laboratory (Abbott Laboratories, Diagnostics Division, Buenos Aires, Argentina) for immunoassy. As typically occurs during abdominoplasty surgery in patients, the swabs became soaked in a pink liquid, which was a mixture of scarce blood and anesthetic.

**Results**

The total absorption of anesthetic without surgery for all 10 pigs averaged 4.94 μg at 15 minutes (Figure 2). At 30 minutes the rate increased slightly to 5.04 μg; it descended to 4.38 μg at 45 minutes and 3.6 μg in the later samples. The lidocaine level during the surgeries was 3.33 μg at 15 minutes, descending to 2.61 μg, 2.23 μg, 1.86 μg, 1.79 μg, and 1.71 μg at 15-minute intervals.

Both with and without surgery, the levels increased substantially during the first 15 to 30 minutes and then descended. The differences between the amount of anesthetic absorbed in these two stages of the study are expressed in percentages in Figure 3. In the operated animals, during the first 15 minutes, 32.6% less of the injected lidocaine was absorbed; at 30 minutes, the level of anesthetic absorption increased to nearly 50%; and at the later time intervals, the levels of anesthetic varied slightly but remained at approximately 50%.

**Summary**

In 4 nonoperated pigs (in which the absorption of anesthetics was complete), the levels of lidocaine increased to more than 5 μg; when those animals underwent abdominoplasty, the levels decreased substantially to within normal limits. In the operated animals, with double the recommended maximal doses, plasma lidocaine levels remained under the critical limits of 5 μg (the level at which clinical signs of toxicity begin to appear). During abdominoplasty in pigs, the plasma lidocaine levels only reached approximately half that of the controls.

**The Absorption Rate and Level of Local Anesthetic Among the Face and Neck, the Pectoral Region, and the Abdominal Wall**

In aesthetic surgery, depending on the operated region, local anesthesia is used to infiltrate different kinds of tissues. In some clinical cases, Mottura3 observed that the
absorption of anesthetics varied if the tissue involved was subcutaneous or muscular. We sought to analyze lidocaine absorption in 3 anatomic regions commonly corrected in aesthetic surgery: the abdomen, as for an abdominoplasty, in which the fat tissue was infiltrated; the thorax and axilla, as for a breast augmentation through the axillary subpectoral approach, in which the muscular tissue was infiltrated; and the face and neck, as for a face lift, in which thin, richly vascularized subcutaneous tissue was infiltrated (Figure 4).

For this study, 10 Duroc-Jersey pigs were selected, each weighing 17 kg. The animals were premedicated with phenothiazide 20 mg/kg intramuscularly 30 minutes before surgery. The femoral artery was cannulated to obtain the blood samples during the thorax and face and neck studies, whereas the internal carotid was cannulated for the abdomen study. The sequence of study in each pig began with the thorax and continued with the face and neck and then the abdomen. A 2-day interval was scheduled between each stage of the study to allow the complete metabolism of the lidocaine infiltrated during the previous stage. For each study, an anesthetic solution with 14 mg/kg lidocaine, 0.23 mL epinephrine 1:1000 and 83-mL saline solution (which meant an epinephrine dilution of approximately 1:400,000) was prepared. For the thoracic study, the entire area of the thoracic wall was infiltrated, from underneath the pectoral muscle, separating it from the ribs, into the subcutaneous tissue where the incision was marked, and into the subcutaneous tissue of the axilla. An equal amount was infiltrated in the face and neck, in the area where face lift is normally performed. For the abdominal study, the abdominal wall adiposity was infiltrated from the inferior border of the costal wall to the inguinal fold and laterally to the anterior axillary line.

Seven blood samples were obtained from each of the study areas at 15-minute intervals and sent to a laboratory (Abbott Laboratories, Diagnostics Division, Buenos Aires, Argentina) for immunofluorescence assay.

Results

Plasma lidocaine levels after thorax infiltration were
between 4.65 μg and 6.28 μg, averaging 5.6 μg. Plasma lidocaine levels after face and neck infiltration were between 3.31 μg and 3.81 μg, averaging 3.5 μg. Plasma lidocaine levels after abdominal infiltration were between 2.30 μg and 2.96 μg, averaging 2.6 μg. The thoracic absorption curve demonstrated a high initial absorption peak at the first 15 minutes, followed by a significant drop (Figure 5). The abdominal absorption curve showed a slow increase for the first 30 minutes, which was maintained for the remainder of the study. The face and neck absorption curve remained very stable at a level between those of the other 2 regions.

The highest absorption levels were found in the thoracic study, in which the pectoral muscle was infiltrated. This was presumed to be the result of the anesthetic distribution within muscular fibers and at the axilla, both of which have a very rich blood supply.

The lowest levels occurred in the abdominal study, in which the infiltration was performed in the fat adiposity. The face and neck absorption levels fell between those of the other two studies, perhaps because the blood supply to the tissues involved in the face and neck study was higher than that of abdominal tissue but lower than that of the pectoral muscle (Figure 6). Comparing the average terms of the three studies, the average level of abdominal absorption (2.6 μg) was less than half that of the thoracic study, whereas the average level of absorption in the face and neck (3.5 μg) was more than half the average thoracic study absorption level (5.8 μg).

**Summary**

Considering that the total amount of lidocaine injected was double the maximal manufacturer’s recommended dose of 7 mg/kg, we can deduce that, at least in the porcine model, the abdomen can be infiltrated 3.57 times,
the face and neck 2.6 times, and the thorax 1.78 times the manufacturer’s recommended dose before reaching the critical 5-μg plasma level at which the clinical signs of toxicity begin to appear. No such signs were observed in the thoracic study, in which this limit was passed, perhaps because the animals were under deep sedation.

Discussion

The absorption of local anesthetics depends on several factors, such as the concentration of drugs, the volume injected, the use of vasoconstrictors, and the vascularization of the region injected. Although the surgeon can control the first 3 factors, absorption of the injected drug varies because diverse tissues have different irrigation characteristics. The abdomen is usually infiltrated in thick, poorly irrigated subcutaneous tissue, compared with the very thin and richly irrigated subcutaneous tissues of the face and neck. In the mammary subpectoral space, the infiltration should be done between the amply vascularized pectoral muscle; the approach is through the axilla, an area that also has a very good blood supply.

The absorption of local anesthetics used for epidural or peripheral nerve blocks in subcutaneous tissue has been widely studied by anesthesiologists.1,6,7,9,10 Local anesthetic absorption during reduction mammoplasty and abdominoplasty surgeries has also been reported.4,5 The literature indicates that cosmetic surgical procedures can be safely performed with the patient under local anesthesia with doses exceeding the standard 7 mg/kg of lidocaine. Surgeons with experience in performing cosmetic surgeries with patients under local anesthesia have observed that a considerable amount of infiltrated fluid is lost during surgery. Mottura3 reported a low absorption of local anesthetic during abdominoplasties, and Klein2 described absorption during lipoplasty with the tumescent technique.

Surgeons with experience in performing cosmetic surgeries with patients under local anesthesia have observed that a considerable amount of this infiltrated fluid comes out during surgery. Mottura3 reported a low absorption of local anesthetic during abdominoplasties, and Klein2 ascertained the amount of fluid lost during lipoplasty with the tumescent technique. Information is also lacking concerning the level of local anesthetic absorption in the face and neck, as compared with levels in the abdomen and in the pectoral region.

The value of this study is that the same animal was infiltrated in these 3 areas of the body, so that a clear comparison could be made. The results demonstrate that the absorption rate varies even when the same concentration and amount of anesthetic solution is used in each of these 3 regions.

Conclusion

In animal studies, we found that approximately 50% of the anesthetic injected for an abdominoplasty is lost during surgery when using a dose twice the manufacturer’s recommended maximal level, leaving the final absorption within safe limits. We also found that when using the same anesthetic concentration, absorption of lidocaine in the abdomen, face and neck, and pectoral area remains low when no surgery is performed, slightly surpassing the 5-μg level, and decreases significantly during surgery.

References