Heating Infiltration Solutions Used in Tumescent Liposuction: Minimizing Surgical Risk

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Background: Liposuction, one of the most common operations performed by plastic surgeons, is not free of complications. One of the most common factors is patient hypothermia, a factor little studied but one capable of producing severe arrhythmias and cardiac arrest. A comparative clinical study was conducted to determine what effect using tumescent infiltration solutions at room temperature and at body temperature has on vital signs.

Methods: Two similar groups of 15 healthy female subjects were studied. In the first group (group A), subcutaneous solutions were infiltrated at room temperature (24°C), and in the second group (group B), solutions were infiltrated at body temperature (37°C). Vital signs (i.e., heart rate, respiratory rate, temperature, and blood pressure) were monitored every 15 minutes until the basal vital signs were attained. Variables such as age, body mass index, infiltrated and aspirated liquids, and surgery time were very similar for both groups.

Results: Although there were differences in heart rate, respiratory rate, and arterial pressure, they were not statistically significant. Nevertheless, the differences between groups A and B for body temperature (34.9 ± 1.1°C versus 35.7 ± 1.3°C, respectively) and for the time necessary to attain basal vital signs (120 ± 8 minutes versus 69 ± 4 minutes, respectively) were statistically significant ($p < 0.05$).

Conclusions: Despite the existence of a significant change in the body temperature in healthy female subjects during manipulation of the temperature of the infiltration solution, this change had no important effect on the intraoperative hemodynamic values. Nevertheless, it could have a more significant effect on patients with greater surgical risk. (*Plast. Reconstr. Surg.* 116: 1077, 2005.)

Liposuction has become an integral part of the stock of techniques used by plastic surgeons. Despite being theoretically simple, this procedure is not free of complications.[1,2] With the passage of time, techniques used in liposuction have evolved into various alternatives. Two of the most commonly used forms are tumescent and superwet.[3,4] Complications may include pulmonary embolism, pulmonary edema, perforation, hemorrhage, oversedation, fluid overload, epinephrine toxicity, and hypothermia.[2,5–7] During liposuction, body temperature diminishes because of injection of cold infiltrating solutions, low operating room temperatures, and injection of cold intravenous solutions. These factors increase catecholamine release, which facilitates ventricular irritability and arrhythmias.[8] For this reason, there are several methods of preventing intraopera-

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tive hypothermia, such as heating of intravenous and infiltrating solutions.[8–10] The aim of our study was to compare the hemodynamic changes that occur during tumescent liposuction using infiltrating solutions maintained at room temperature versus infiltrating solutions maintained at body temperature.

Patients and Methods

A randomized clinical trial was carried out. Two groups (groups A and B) were formed, with 15 patients in each group. Single sampling randomization was performed. Group A was the control group and group B was the study group. Both groups consisted of 15 healthy female patients between 18 and 30 years of age who were candidates for body contour surgery. All the patients had a body mass index (kilograms per square meter) between 28 and 30, visible and healthy auditory canals, and an American Society of Anesthesiologists class I anesthesia risk. Patients who had systemic diseases or were taking medications that might affect cardiovascular system or body temperature regulation were not included on the study. All the patients agreed to participate in the study, and all signed a written consent form.

In group A, patients' tumescence was obtained by infiltrating solutions maintained at room temperature, whereas patients in group B were infiltrated with solutions heated at body temperature (37°C). Solutions were warmed in a microwave oven for 2 minutes and administered at the selected temperature. The heating time of the solutions was calculated beforehand so that a temperature of 37°C was obtained at the moment of being infiltrated into the subcutaneous tissues. For this, two factors were considered that produce heat loss through conduction. The first was the time lapse between the final heating of the solution in the microwave oven and the time elapsed for infiltration. The second consideration was fluid passage through the administration tubing and cannula. The fluid temperature when removed from the microwave was 38.5°C to compensate for heat loss caused by the abovementioned factors. Solutions were prepared with epinephrine after microwave heating.

During surgery and the postoperative recovery period, the patient's body temperature was measured every 15 minutes using a Procheck IR 1DA1 digital infrared tympanic thermometer. At the same time, heart rate, respiratory rate, and arterial blood pressure were measured every 15 minutes using a Criticon 4000 vital.check model. Patients of both groups had liposuction on several body locations, including upper and lower back, flanks, trochanteric, internal thigh, and abdominal areas. All patients had epidural anesthesia. The infiltrating solution was composed of normal saline 0.9% plus 1 mg of epinephrine. The intravenous fluids were administered to all patients at surgical room temperature, which was between 24°C and 25°C. Infiltration was accomplished through 2.5-mm cannulas, through a Randolph Econ II Vari-Flow pump. All the solutions were prepared by the same person and administered by different plastic surgeons participating in the study. Liposuction was performed with a liposuction machine (Cosmetech SSB-IV), according to the patient's requirements. Liposuctioned areas included flanks, upper and lower back, internal thigh, and trochanteric and abdominal regions. Infiltration was accomplished in a symmetric manner in the different parts of the body. Initially, it was performed in the posterior region of the body including flanks, upper and lower back, internal thigh, and trochanteric area. Finally, infiltration was performed in the anterior region including the abdominal area. Infiltration time of the posterior and the anterior regions fluctuated between 12 and 15 minutes each. Measurement of the amount of infiltrated fluids and the lipoaspirated material was performed every 15 minutes to determine whether there existed any correlation with body temperature changes and vital signs. These measurements were performed during the entire surgical and recovery period. The means were averaged over time for each patient and all the patients' means were used to conform the group mean. All the results were reported as mean and SD with statistical analysis using the Wilcoxon test and the Mann-Whitney *U* test; $p < 0.05$ was considered as significant.

Results

Both groups were similar and there was no statistically significant difference between ages, 24.1 years versus 24.8 years ($p = 0.789$), or body mass index, 28.9 versus 29.2 ($p = 0.708$) (Table I). Furthermore, there was no statistical difference between groups A and B in tumescent infiltrate quantity (8350 ml versus 9800 ml, $p = 0.425$) or aspirated liquid (5960 ml versus 5973 ml, $p = 0.775$). Also, there was no significant difference between minutes elapsed

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TABLE I
Clinical Characteristics of Both Groups

	Group A ($n = 15$)	Group B ($n = 15$)	p*
Age, years	24.1 ± 2	24.8 ± 3	0.789
Body mass index, kg/m^2	28.9 ± 2	29.2 ± 2	0.708

*Mann-Whitney U test, $p < 0.05$.

during surgery (205 versus 204, $p = 0.934$). These intraoperative characteristics are compiled in Table II. Statistically significant differences were encountered when determining vital signs and hemodynamic changes. These differences were present in the temperature during surgery, and in the time required to return to basal vital signs after completion of the operation. Time in minutes to recuperate to the basal state temperature and vital signs was 120 ± 8 and 69 ± 4 in groups A and B, respectively ($p < 0.0001$) (Table II).

With the exception of temperature, there were no statistically significant differences for vital signs during the intraoperative period between both groups. For example, pulse rate (beats per minute) was noted at 90.9 ± 5.1 versus 90.4 ± 3.5 ($p = 0.88$); respiratory rate (breaths per minute) was noted at 20.7± 1.4 versus 18.6 ± 2.3 ($p = 0.62$); and the mean arterial pressure was 78.7 ± 3.7 mmHg versus 74.9 ± 4.2 mmHg ($p = 0.174$). On examining the correlation between temperature and the other vital signs, there was no significant correlation. However, there was a statistically significant difference in the intraoperative body temperature between groups. In group A, it was 34.9 ± 1.1°C; in group B, it was 35.7 ± 1.3°C in group B. The difference was statistically significant ($p = 0.046$) (Table III).

DISCUSSION

At the present time, among plastic surgeons, liposuction is one of the most frequently performed procedures.[1] Despite being a safe procedure in expert hands, it is not free of morbidity and mortality.[2] Since its beginning, liposuction has evolved in all aspects. The age range of patients has widened, the quantity of lipoaspirate is greater, the surgical and anesthetic risks have diminished, and the hospital stay has been shortened. Likewise, monitoring and fluids management used in surgery have been modified. The popularization of the tumescent technique has permitted a wider scope of this procedure.[3,4] However, along with this evolution there have appeared factors that may influence the appearance of liposuction complications, such as pulmonary embolism, pulmonary edema, perforation, hemorrhage, excessive sedation, overhydration, epinephrine toxicity, and hypothermia.[2,7]

TABLE II
Surgical Characteristics in Both Groups

	Group A ($n = 15$)	Group B ($n = 15$)	p*
Infiltrated liquid, ml	8350 ± 1200	9800 ± 1300	0.425
Aspirated liquid, ml	5960 ± 850	5973 ± 675	0.775
Surgical time, minutes	205 ± 12	204 ± 10	0.934
Recuperation time in basal temperature, minutes	120 ± 8	9.3 ± 4.5	0.0001*

*Mann-Whitney U test $p < 0.05$.

TABLE III
Constant Intraoperative Vital Signs in Both Groups

	Group A ($n = 15$)	Group B ($n = 15$)	p
Heart rate, beats/minute	90.9 ± 5.1	90.4 ± 3.5	0.88
Respiratory rate, breaths/minute	20.7 ± 1.4	18.6 ± 2.3	0.62
Body temperature, °C	34.9 ± 1.1	35.7 ± 1.3	0.04
Mean blood pressure, mmHg	78.7 ± 3.7	74.9 ± 4.2	0.17

Hypothermia is defined as a body temperature decline less than 36.5°C,[11] and its correlation to liposuction has been infrequently studied. When the tumescent technique of liposuction is performed, several factors exist that contribute to body temperature loss during surgery and in the immediate postoperative period.[12] The principal factor is injection of cold solutions into the subcutaneous tissues. These solutions, in the majority of cases, are the same temperature as the surgical room. Another important factor is the low temperature of the operating room itself. This low temperature is secondary to the necessary recycling of air, and is also necessary for the surgeon's comfort. The last factor is the temperature of the solutions used intravenously, which are used cold as infiltration solutions. All these factors contribute to heat loss, which can result in catecholamines liberation, which can provoke arrhythmias and even cardiac arrest.[8] Among the causes of death caused by liposuction, in addition to the known causes, 5.4 percent are attributable to cardiorespiratory failure, and another 28.5 percent are attributable to unknown causes.[13] Hypothermia might have contributed in an important manner to the

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above percentages. Because of this, multiple studies have studied ways to avoid hypothermia or to prevent it. Among the preventative means mentioned are heating intravenous fluids, heating infiltration solutions, using thermal sheets during the postoperative period, and maintaining the operating room temperature at 82°F.[9,12] Nevertheless, there have been no studies that determine the relationship between hypothermia and vital signs and the hemodynamic state.[8] To date, studies only point out that heating the infiltration solutions provides patients with more comfort and less pain sensation.[9,10]

The digital infrared tympanic thermometer was chosen to measure body temperature because clinical studies have shown that it approximates most accurately the body's core temperature. This method has demonstrated great efficacy and reproducibility, overcoming the traditional methods and lacking the invasiveness and risks characteristic of a pulmonary venous catheter.[14,15] The only indispensable prerequisite necessary beyond understanding its function is a normal auditory canal and a visible normal appearing tympanic membrane, because any obstruction or abnormality affects temperature measurement. This type of thermometer has been used successfully in other scientific studies where exact body temperature measurement is of primary importance.[14]

The method used for heating solutions in this study was a microwave oven because it is simple, practical, and economical. Because each microwave oven is different in terms of intensity, it was first necessary to calculate the ideal time needed to attain the temperature needed for the solutions, for which a liquid thermometer was used. In this case, each individual solution required 2 minutes of heating so that surgical time would not be significantly delayed.

In the present study, we found that despite the existence of a significant change in body temperature according to the temperature of the infiltrating solutions, this change did not have an important effect on the hemodynamic constants intraoperatively. Nevertheless, the recuperation time of the basal temperature during the postoperative period was affected, which has been associated with postoperative morbidity. Because of this, it is very important to point out that, at the present time, patients who undergo liposuction have greater age ranges, greater body mass indices, greater anesthetic-surgical risks, larger lipoaspirate amounts (megaliposuction), and shorter hospital stays. These variations in body temperature and hemodynamics could have a more significant effect on these types of patients, because in our study these risk factors were not included. Therefore, it is important that future clinical studies that focus on these clinical characteristics be performed.

It is important to mention that, although it was not the objective of our study, certain factors were observed in the group of patients who were infiltrated with body temperature solutions. While visually evaluating the aspirated fluids, greater amounts of intraoperative bleeding, postoperative bleeding, or bruising were not observed. In the same manner, there was no important variation in the vital signs or the patient's body temperature, taking into account the body area and/or the amount of infiltrated and aspirated fluid. Chills during the postoperative period, which are more prevalent in patients undergoing tumescent liposuction, were not reported in the patients infiltrated with body temperature solutions.

Conclusions

The results obtained in this study demonstrate that, in addition to improving the comfort of the patient, heating subcutaneous infiltrating solutions used in tumescent liposuction provides greater stability of vital signs, and this can be achieved in a rapid, simple, and economical manner in the operating room.

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