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Comparative Analysis of the Effectiveness of Tranexamic Acid in Controlling Surgical Blood Loss in Patients Undergoing Liposuction

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Abstract

Background Liposuction is one of the most popular plastic surgeries, and blood loss is one of its major complications. Tranexamic acid (TXA), an antifibrinolytic drug, has been shown to reduce blood loss in many surgeries. In this prospective study, the effect of TXA on blood loss in patients, who underwent three different procedures including suction-assisted lipoplasty, vibrational amplification of sound energy at resonance (VASER)-assisted lipoplasty and LipoSaver, was compared.

Methods Thirty-five patients were enrolled in the study. Patients who underwent VASER2.2 technology were assigned to group 1 (n = 12), patients who underwent LipoSaver2000 technology were assigned to group 2 (n = 12), and patients who underwent SAL were assigned to group 3 (n = 11). For each patient, demographic data, tumescent solution and aspirate volumes, and hemoglobin and hematocrit values in the aspirate were compared.

Results There was no difference in tumescent volume between the groups, but the aspirate volume from group 3 was significantly higher than the aspirate volume of group 1 (p = 0.001). No difference was detected in terms of Hgb and Hct values in each liter of aspirate, both in terms of the applied liposuction method and TXA application. Additionally, no correlation was observed between gender, age, total inflated volume, total aspirate volume and device use time and Hgb and Htc values in the aspirate.

Conclusion No significant differences were determined between lipoaspirate, VASER, LipoSaver and SAL in terms of blood loss, and TXA application did not significantly change the Hgb and Htc values in lipoaspirate.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Vibrational amplification of sound energy at resonance · LipoSaver · Suction-assisted lipoplasty · Tranexamic acid · Blood loss

Introduction

According to global statistics published by the American Society of Plastic Surgeons in 2020, 2.3 million plastic surgery procedures were performed worldwide [1]. Aesthetic plastic surgery procedures are becoming more popular in recent years. Liposuction is a minimally invasive surgical procedure performed for reasons such as body shaping, body fat reduction and soft tissue augmentation [2, 3]. According to 2020 data, liposuction is one of the most popular plastic surgeries, with approximately 300,000 procedures performed in both genders [4].

Since the introduction of liposuction in the 1980s, its popularity has increased significantly and new technological advances have been made in this field. In addition to traditional suction-assisted liposuction (SAL), there are many techniques including radiofrequency-assisted lipoplasty, water jet-assisted lipoplasty, ultrasound-assisted lipoplasty (UAL), power-assisted lipoplasty, laser-assisted lipoplasty and vibrational amplification of sound energy at

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resonance (VASER)-assisted lipoplasty [5, 6]. In UAL, ultrasonic waves emulsify the fat in the target region and cause less tissue trauma than other lipoplasty techniques. VASER-assisted lipoplasty is a third-generation internal ultrasound system that uses small-diameter multi-ring probes instead of a hollow cannula, emulsifying the fat in the target region by providing minimal force [7].

Liposuction involves shorter surgery and recovery times, and lower complication rates than many other surgical procedures. The most common complications are contour irregularity, ecchymosis, hematoma, venous thromboembolism, seroma and surgical site infection [3]. These complications, which do not generally pose a life-threatening risk to patient safety, are associated with decreased patient satisfaction [8]. Although a number of surgical techniques have been developed to minimize these complications, bleeding and hematoma remain a major concern in high-volume liposuction cases. For this reason, plastic surgeons have started to search for auxiliary drugs that will reduce bleeding complications [9].

Tranexamic acid (TXA) has been successful to preventing bleeding and blood transfusion in cardiac, obstetric, trauma and orthopedic surgeries [10]. In 2016, a meta-analysis reported that TXA could reduce blood loss and transfusion requirements in craniomaxillofacial and plastic surgery [11]. Additionally, Brown et al. [12] reported that the combined use of local and intravenous (IV) TXA in rhinoplasty reduces preoperative bleeding and postoperative ecchymosis. Similarly, the bleeding-reducing effects of TXA infiltration solution have been observed in facelifts and rhinoplasty [13]. Although the beneficial role of TXA in various plastic surgery operations has been demonstrated, there are not many studies on the effect of TXA on blood loss in liposuction. In this study, safe surgical approaches of a plastic surgeon who has spent the last 15 years with liposuction are presented. In this study, the effects of TXA on bleeding during liposuction procedures such as VASER, LipoSaver2000 and SAL were compared.

Materials and Methods

Patients

This prospective study was conducted in accordance with the tenets of the Declaration of Helsinki, and written informed consent was obtained from all subjects. Exclusion criteria from the study were determined as having a history of bleeding disorders or being treated with blood thinners, having active menstruation on the day or week of the procedure, having previous history of cancer, having any type of liposuction surgery before and having BMI of 35 and above. Demographic data of all patients, aspirate volume and total volume of tumescent solution, preoperative and postoperative hemoglobin (Hgb) and hematocrit (Htc) values in blood and aspirate were recorded.

Thirty-five patients included in the study were randomly divided into three groups. Patients who underwent VASER2.2 technology were assigned to group 1 (n = 12), patients who underwent LipoSaver2000 technology were assigned to group 2 (n = 12), and patients who underwent SAL were assigned to group 3 (n = 11). Tumescent solution without TXA was applied to the left waist region of all patients, and tumescent solution with TXA was applied to the right waist region. Tumescent solution without TXA contained one mg adrenaline and lidocaine 100 mg/5 ml in 1000 cc ringer lactate. Tumescent solution with TXA contained one mg adrenaline, lidocaine 100 mg/5 ml and 500 mg TXA in 1000cc ringer lactate. In all groups, solution infiltration was applied with the infiltration section of the VASER2.2 device with the power and speed to deliver 5.5 ml per second with a 1.2 mm multi-hole infiltration cannula. Infiltration was applied in the order of deep, middle and superficial levels in all groups, regardless of the technique to be used. Tumescent solution administered and aspirate volumes taken for each patient were recorded.

Surgical Procedure

Surgical Technique Group 1

VASER application began following fluid infiltration of both waist regions. In order to avoid any difference in the duration between infiltration and VASER initiation, infiltration was started from the right region of the waist in all patients and then applied to the left region of the waist. VASER was applied to the right region of the waist for the same infiltration time that was applied to the left region of the waist. Then, VASER was used on the left region of the waist, thus eliminating the difference in the waiting duration of the liquid. In the waist region application of VASER, a 5-ring 3.7-mm-diameter probe was used in 100% C power mode. Then, aspiration was performed using 4-mm-diameter reverse triangle tip liposuction cannulas into separate collection containers on the right and left with a 24 Pascal VASER device aspiration section with the same pressure. A 20-min-filtration period was allowed for both collection containers before samples were taken from the aspirates taken into different collection containers. In this way, all the liquid and HGB in the oil were collected at the bottom (Fig. 1), and then, samples were taken from each group and sent to the laboratory for content analysis with blood collection tubes.

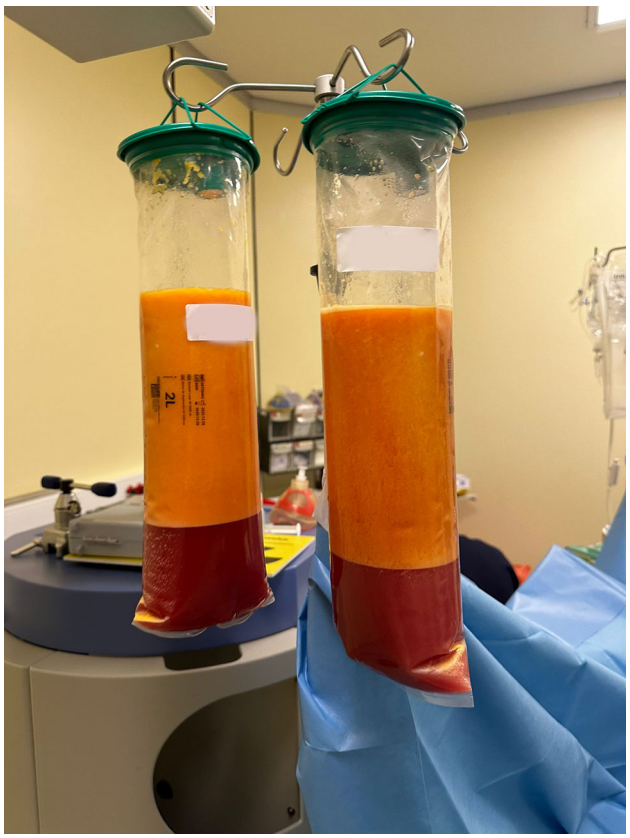

Fig. 1 Lipoaspirate containing fat and liquid

Surgical Technique Group 2

The LipoSaver2000 application began following fluid infiltration of both waist regions. In order to avoid any difference in the duration between infiltration and LipoSaver2000 initiation, infiltration was started from the right region of the waist in all patients and then infiltration was applied to the left region of the waist. LipoSaver2000 was applied to the right region of the waist for the same infiltration time that was applied to the left region of the waist. In LipoSaver waist region application, a 5-ring 3.7-mm-diameter probe was used in 99% N power mode. Then, aspiration was performed using 4-mm-diameter reverse triangle tip liposuction cannulas into separate collection containers on the right and left, using the 24 Pascal VASER device aspiration section with the same pressure. Samples from the aspirates taken into different collection containers were obtained similar to group 1.

Surgical Technique Group 3

Infiltration started from the right region of the waist, then moved to the left region of the waist. Before proceeding with the liposuction process, 20 min was waited and the traditional method was prepared for liposuction. Then, aspiration was performed using 4-mm-diameter reverse triangle tip liposuction cannulas into separate collection containers on the right and left, using the 24 Pascal VASER device aspiration section with the same pressure. Liposuction was applied and completed between the left and right waist regions with five-minute intervals, thus respecting the infiltration time and effectiveness. Samples from the aspirates taken into different collection containers were obtained similar to group 1.

Statistical Analysis

Statistical evaluation was made using SPSS 20 statistical software. The Kolmogorov–Smirnov test was used to evaluate the suitability of the measured data for normal distribution. Mean, standard error, minimum and maximum values of continuous variables, and n and percentage values of categorical variables were given. Chi-square test was used to compare categorical data, one-way ANOVA was used to compare normally distributed continuous data, and Kruskal–Wallis test was used to compare non-normally distributed continuous data. Pearson correlation was performed for the correlation between variables. A p value of less than 0.05 was considered statistically significant.

Results

Demographic data of the participants enrolled in the study are given in Table 1. There were a total of 35 participants in the study, including 28 females and 7 males. The average age of the participants was 36.97 ± 1.46 (22–56) years, and 34.3% (n: 12) of the participants were smokers. No differences were observed between the groups in terms of gender, age, BMI and smoking. LipoSaver working time in group 2 was significantly longer than VASER working time in group 1 ($p = 0.019$).

Hgb and Hct values in the participants' aspirates are given in Table 2. There was no difference in terms of tumescent volume between groups or within groups. The aspirate volume from group 3 patients who underwent SAL was significantly higher than the aspirate volume from group 1 patients who underwent VASER ($p = 0.001$). No differences were determined in terms of Hgb and Hct values in the aspirates between the groups or when TXA was applied.

The correlation of Hgb and Htc values in the lipoaspirate and other parameters is given in Table 3. No correlation was observed between gender, age, total tumescent volume, total aspirate volume and duration of device use and the Hgb and Htc values in the aspirate.

Table 1 Comparison of demographic data of the participants.

	All participants	Group 1	Group 2	Group 3	Statistics
Gender					
Female	28 (80%)	10 (83.3%)	10 (83.3%)	8 (72.7%)	X^2=0.530 p=0.767
Male	7 (20%)	2 (16.7%)	2 (16.7%)	3 (27.3%)	
Smoking					
Yes	12 (34.3%)	7 (58.3%)	1 (8.3%)	4 (36.4%)	X^2=1.875 p=0.392
No	23 (65.7%)	5 (41.7%)	11 (91.7%)	7 (63.6%)	
Age, years	36.97±1.46 36 (22–56)	37.58±2.35 37.5 (23–50)	36.66±2.18 35.50 (24–50)	36.63±3.25 34 (22–56)	F=0.043 p=0.958
BMI	25.91±0.64 25.60 (19.36–33.64)	25.62±0.87 25.78 (20.31–29.76)	24.97±1.17 24.97 (19.36–30.49)	27.16±1.30 25.51 (21.63–33.64)	F=0.986 p=0.385
VASER time (minutes)		9.62±0.37 10 (7–12)	12.36±1.04 12 (9–20)		t=-2.549 p=0.019

X^2=Chi-square test, F= One-way ANOVA. [a] p<0.05 compared to group 1.

Table 2 Comparison of hemoglobin and hematocrit values in participants' aspirates.

	Group 1 Without TXA	Group 2 With TXA	Group 3 Without TXA	Statistics With TXA	Without TXA	With TXA	
The volume of tumescent solution injected into each liposuction area (ml)	1254.16±70.02 1300 (600–1500)	1254.16±70.02 1300 (600–1500)	1508.33±127.00 1500 (1000–2400)	1516.66±127.22 1550(1000–2400)	1590.90±45.63 1600 (1350–1800)	1586.36±45.77 1600 (1350–1800)	F=3.056 p= 0.160
The total aspirated volume from each area (ml)	816.66±48.59 800 (600–1100)	783.33±42.78 750 (550–1000)	941.66±97.66 925 (400–1500)	941.66±92.07 1000 (400-1400)	1200.00±87.38 [a] 1200 (750-1650)	1159.09±81.96 [a] 1150 (750-1600)	F=4.808 p= 0.001
Hemoglobin in per liter of Aspirate	0.50±0.12 0.34 (0.13–1.71)	0.56±0.09 0.52 (0.13–1.17)	0.38±0.06 0.28 (0.13–0.80)	0.41±0.05 0.33 (0.16–0.71)	0.39±0.11 0.26 (0.06–1.38)	0.44±0.13 0.21 (0.06-1.46)	F=0.488 p= 0.784
Hematocrit in per liter of Aspirate	0.71±0.24 0.48 (0.0–2.57)	0.86±0.25 0.83 (0.0–2.91)	0.41±0.11 0.38 (0.0–1.0)	0.45±0.14 0.32 (0.0–1.43)	0.87±0.37 0.53 (0.0–4.28)	0.91±0.45 0.0 (0.0–4.08)	F=0.614 p= 0.690

F= One-way ANOVA, [a] p<0.05 compared to group 1.

Discussion

In this study, the amounts of Hbg and Hct in the aspirates of patients who underwent VASER, LipoSaver and SAL were investigated. Additionally, the effectiveness of TXA applied to reduce the amount of bleeding was compared. No differences were observed in terms of Hgb and Hct in the aspirate, both in terms of the methods applied for liposuction and whether TXA was applied or not.

The popularity of liposuction, one of the most frequently performed plastic surgery procedures, has increased every year. However, due to justified concerns regarding patient safety, limits have been established on the volume of fat that can be aspirated. These limitations are largely due to blood loss and bleeding-related hemodynamic changes that occur during liposuction [14]. In order to reduce blood loss in liposuction procedures, practices such as infiltration of saline solution with epinephrine and lidocaine,

Table 3 Correlation of hemoglobin and hematocrit in the aspirate and other parameters.

	Without TXA				With TXA			
	Hemoglobin		Hematocrit		Hemoglobin		Hematocrit	
	r	p	r	p	r	p	r	p
Gender	− 0.86	0.622	− 0.092	0.599	0.027	0.880	0.017	0.922
Age	− 0.093	0.597	− 0.167	0.339	− 0.220	0.204	− 0.275	0.110
Tumescent volume	0.297	0.111	0.222	0.239	0.065	0.734	0.064	0.738
Aspirated volume	0.152	0.422	0.151	0.425	0.097	0.612	− 0.009	0.961
VASER time	0.102	0.642	0.171	0.435	0.088	0.690	− 0.020	0.930

r Pearson correlation coefficient

compression and the use of drains have been employed before liposuction [15]. Even with these techniques implemented, blood loss remains a concern, especially in high-volume liposuction cases. Many studies in recent years suggest that TXA can be used in plastic surgery to reduce blood loss, hematoma formation and bruising.

Rohrich et al. [16] documented that TXA has the potential to reduce bleeding, bruising and edema, as well as increase patient satisfaction in plastic surgery operations. Eftekharian et al. [17] reported an increase in surgical field quality and surgeon satisfaction following TXA application during rhinoplasty. Other studies have also determined that TXA has the potential to increase surgical field visibility and shorten surgery time [18, 19]. In their study investigating the use of topical TXA in dermatological surgery, Zilinsky et al. [20] noted that blood loss decreased to control in patients who were given 2% lidocaine diluted 1:1 with 100 mg/1 mL TXA before surgery. Another study showed that a topical solution of 2.5% TXA reduced bleeding by 39% in breast reduction surgery [21]. However, there are not many studies that have investigated the use of TXA in liposuction.

In their liposuction studies, Fayman et al. [22] infiltrated a solution without TXA into one flank and a solution with TXA (500 mgTXA in 500 cc solution) into the other flank. In their bruising analysis on the first and seventh days after surgery, they determined less bruising in the TXA group. In their study of 10 women, Cansancao et al. [23] determined that preoperative and postoperative 10 mg/kg IV TXA administration significantly reduced the volume of blood loss per liter of lipoaspirate. In their cohort of 50 women, Rodriguez-Garcia et al. [24] added 1000 mg TXA to the tumescent solution (1000 ml physiological solution + 1 cc adrenaline) of the patients in the TXA group. They reported that the Hct value in the TXA group, according to the aspirated volume after liposuction, was significantly lower than the control group. In 36 patients who underwent breast reduction treatment with liposuction and resection, 0.5 g/5 mL TXA solution was infiltrated into one breast and a solution without TXA was infiltrated into the other breast (mean infiltration volume 370 ml (range: 240–500 ml)). They determined that the blood volume in the lipoaspirated volume in the TXA group was 38% less than the blood volume in the non-TXA group [25]. In their study, where El Minawi and colleagues [26] performed liposuction on different parts of the body, they applied 8.1 mg/kg TXA for the local TXA group and 7.8 mg/kg TXA for the IV group. They determined that locally applied TXA significantly reduced blood loss per milliliter and Htc values in lipoaspirate, while IV TXA only caused a numerical decrease.

In this study, we compared the effects of different liposuction techniques and TXA application on Hgb and Htc values in lipoaspirate. In fact, liposuction was applied to other regions of all patients, along with their waist region in the same session, and their blood Hgb and Htc levels were measured before and after the surgery. The difference between preoperative and postoperative Hgb values was 2.12 ± 0.38 (0.20–4.0) g/dL in group 1; 2.37 ± 0.40 (0.70–4.60) in group 2 g/dL; and 2.37 ± 0.24 (1.30–3.60) g/dL in group 3 that decreased significantly. However, there was no significant difference between the groups in terms of decrease in Hgb values. Since the effectiveness of TXA on bleeding was evaluated only in the waist region, only lipoaspirate in the waist region was evaluated. For this reason, blood Hgb values were not added to the findings section and were not discussed. In our study, it was determined that TXA application had no significant effect on Hgb and Htc values in lipoaspirate in all groups. The results of our study contradict the results of previous studies conducted with TXA. In our study, we added 500 mg TXA to 1000 cc tumescent solution. However, the amount of TXA used in the above-mentioned studies was higher than the TXA used in our study. Therefore, the amount of TXA in the infiltration solution has an effect on the amount of bleeding in the lipoaspirate. In our study, it was also determined that gender, age, tumescent solution volume, aspirate volume and VASER duration were not related to Hgb and Htc in the aspirate.

Garcia et al. [27] investigated the effect of SAL and VASER on bleeding in lipoaspirate in patients who underwent lipoplasty on the flank and back sides. They determined that the average Hgb content of the SAL aspirate was 7.5 times higher than the VASER aspirate, and the average Hct content of the SAL aspirate was 6.5 times higher than the VASER aspirate. Similarly, Nagy and colleagues [28] reported that VASER-assisted lipoplasty treatment resulted in a statistically significant 26 percent reduction in blood loss compared to SAL. (NINE) In our study, we determined that the liposuction techniques applied in both the TXA and non-TXA groups were not superior to each other regarding bleeding in the lipoaspirate.

The strengths of our study were that all liposuctions were performed by the same surgeon, different liposuction techniques were compared, lipoaspirate was taken from the same regions of the patients, and Hgb and Htc changes in each liter of lipoaspirate were examined. The first limitation of our study was the small patient population. Another limitation was that, although efforts were made to ensure that the infiltration time was equal in all groups, the practice was not objective and there may have been differences between the infiltration times. Also, our study provides a preliminary data set, and research with larger samples and standardized methods is needed to draw a definitive conclusion on TXA's effects in liposuction.

As a result, in our study, we observed that TXA application did not significantly change the Hgb and Htc values in lipoaspirate. We also determined that VASER, LipoSaver and SAL were not superior to each other regarding blood loss in lipoaspirate. In this study, blood loss in aspirate was compared using different technologies and different solutions. One of the important factors in the lack of statistical difference in bleeding diatheses is the deep-to-superficial compression and controlled precision liposuction technique used by the surgeon. Moreover, although we have seen that TXA has no effect on reducing bleeding, it should be kept in mind that incorrect and superficial infiltration may cause superficial skin necrosis by affecting the superficial dermal and subdermal vascular network. The effectiveness of both TXA and different liposuction techniques on blood loss in liposuction applications needs to be analyzed with standardized methods.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Human and animal rights, or ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was obtained from all participants.

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