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Abstract

Background Venous thromboembolism (VTE) is a serious complication of cosmetic surgery, and studies have suggested that the incidence is not insignificant in facelift surgery. Use of local anesthesia over general anesthesia and shorter operative times are probable contributing factors to lower VTE incidence. Because there have been no large-scale assessments of VTE in facelifts as such, we investigated VTE incidence and relevant factors in facelift surgeries performed under local anesthesia only.

Methods We conducted a retrospective multicenter survey of facelift surgeons who utilize the American Society of Anesthesiologists level 1 oral anxiolysis and local diluted lidocaine anesthesia technique. Anonymous online surveys were sent to surgeons with questions regarding facelifts performed and VTE incidence over the previous 19 months.

Results Seventy-seven surgeons (93 % response rate) completed the survey, with 74 eligible surgeons reporting at least one facelift. Respondents reported five VTE events, for an overall VTE incidence of 1 event in 5,844 surgeries. Surgeons who reported performing facelifts at high volumes (>500 facelifts in 19 months) had a significantly lower VTE incidence than lower-volume surgeons ($p = 0.011$). High-volume surgeons also reported a significantly lower average operative time ($p = 0.016$), but for surgeries that did or did not result in VTE, there was no significant difference between surgeon-reported average operative times.

Conclusion The low VTE incidence in this facelift series supports prior understanding that there is a low risk of VTE in surgery performed under local anesthesia and in surgery with shorter operative times. Limiting ancillary procedures to the face likely reduces operative time and likely also contributes to a lower VTE rate. The data further suggest that physicians performing facelifts more frequently tend to have shorter average operative times and overall lower VTE incidence.

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 Facelift · Rhytidectomy · Local anesthesia · Tumescent anesthesia · Deep vein thrombosis · Pulmonary embolism · Venous thromboembolism · Complications

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Introduction

VTE Incidence in Surgery

Venous thromboembolism (VTE), which includes both deep vein thrombosis (DVT) and pulmonary embolism

(PE), is a significant medical concern. It is estimated that ~2 million people develop VTE each year in the US, and PE is a major cause of preventable death resulting in over 200,000 deaths each year.

While postsurgical VTE incidence varies greatly by report and by surgical specialty, risk for VTE is a significant concern for surgeons in all fields. On the one extreme, without VTE prophylaxis, incidence is as high as 70 and 84 % in orthopedic surgery for patients undergoing hip and knee surgery, respectively [4, 28]. Additionally, incidence of postoperative DVT in some general surgery studies has been reported to be as high as 30–40 % [6, 9, 28]. In other specialties such as head and neck surgery, the VTE incidence has been reported to be significantly lower at 0.3 % [22].

In plastic surgery, concern about postoperative VTE has increased as more studies have shown VTE to be a significant postoperative risk [12, 17, 23, 26, 33]. Seruya et al. [26] estimated that overall there are 33,000 VTE events each year following plastic surgery. In abdominoplasty, VTE incidence has been reported in various studies to be about 1–3 % [12, 23]. This estimated incidence increases further when abdominoplasty is combined with other procedures such as liposuction or breast augmentation [4, 11, 12, 14]. Voss et al. [32] reported a 6.6 % PE incidence rate for patients who underwent concurrent abdominoplasty and gynecology procedures.

VTE Incidence in Facelift Surgery

In an American Association for Accreditation of Ambulatory Surgery Facilities (AAAASF) report of mortality in outpatient surgery, PE was the major cause of postoperative death, accounting for over half of the 23 deaths reported from more than 1.1 million outpatient surgical procedures [17]. Following abdominoplasty, facelift was the procedure associated with the second greatest number of the reported mortality cases. In 2001, Reinisch et al. [24] published the results of a high-compliance (80 % response rate) retrospective survey of 342 facelift surgeons, reporting a total of 9,937 facelift procedures over a 12 month period, the first large-scale study of VTE incidence in facelift surgery. Of the 9,937 facelift procedures, there was one death from PE, for a mortality rate of ~0.01 %. In total, there were 35 DVT and 14 PE events reported, indicating ~1 VTE event in every 200 cases (0.49 % incidence) [24]. Recently, Abboushi et al. [1] conducted a retrospective chart review for a 6 year period at a single center and found 2 DVTs out of 630 patients reviewed (0.32 % incidence) who had undergone facelift surgery under general anesthesia [1].

While reports of VTE incidence in facelift surgery show a relatively low incidence, comparable to the reported incidence in head and neck surgery, the risk remains significant enough to warrant surgeon concern and to promote prophylaxis strategies to minimize risk [21, 24, 25]. VTE events are serious complications in any surgical field, but in cosmetic surgery where patients have high expectations and adverse events are subject to greater public scrutiny, efforts to understand the factors that increase complication risk and how to improve patient safety demand even greater attention.

While Abboushi et al. [1] reported facelift surgeries performed under general anesthesia only, Reinisch et al. [24] found a significant difference in VTE incidence between patients who underwent facelift surgery under general anesthesia and patients who underwent facelift surgery under IV sedation or local anesthesia only. For patients who had general anesthesia ($n = 4{,}323$), VTE incidence was 0.95 %, or ~1 VTE event in 100 facelift patients. For patients who had IV sedation or local anesthesia ($n = 5614$), on the other hand, VTE incidence was 0.14 %, or ~1 VTE event in 700 patients. This finding is consistent with VTE incidence studies in other surgical specialties evaluating for anesthesia modality. For instance, in hip fracture surgery, the incidence of DVT decreases from 51 % when performed under general anesthesia to 30 % when performed under regional anesthesia [30]. Reinisch et al. [24] and Abboushi et al. [1] also noted that patients who sustained a VTE event had relatively longer operative times. This observation is consistent with studies in hip arthroplasty [27], neurosurgery [29, 31], and general surgery [5].

Incidence of VTE in facelift patients who had local anesthesia alone has not been reported. Although Reinisch et al. [24] suggested an incidence of 1 VTE in 700 patients who undergo facelift surgery under "local or IV sedation," there have been no studies that examined VTE incidence in facelift surgery under local anesthesia only. Furthermore, risk factors for VTE, such as operative time and surgeon experience, require additional study in facelift surgery. To better characterize the impact of local anesthesia alone and operative time on VTE incidence in facelift surgery, we conducted a large-scale, multicenter survey of facelift surgeons who perform facelifts under the strict American Society of Anesthesiologists (ASA) level 1 oral anxiolysis and local diluted lidocaine anesthesia protocol only.

Materials and Methods

An anonymous online-based survey (Survey Monkey®, Palo Alto CA, www.surveymonkey.com) was sent via email to all physicians employed at Lifestyle Lift at the time of survey distribution (August 2012). Lifestyle Lift has centers across the United States and focuses on facial

rejuvenation procedures performed on an outpatient basis. All surgeons comply with an ASA level 1 oral anxiolysis and diluted lidocaine local anesthesia technique for all facelift procedures. Anxiolysis is provided through oral benzodiazepine with or without oral pain medication delivery, with no use of intramuscular medication, intravenous sedation, or general anesthesia. Routine postoperative follow-up is provided (24 h, 1 week, 4 or 6 weeks, and 6 months) and additionally as needed. Ancillary procedures are commonly performed with the facelift but are limited to facial rejuvenation procedures such as blepharoplasty, facial fat grafting, fractional CO_2 laser resurfacing, brow lift, and chin implant. Nonfacial procedures such as body liposuction and breast augmentation are not offered or performed.

The survey was kept as brief as possible to maximize participation and survey completion. All responders were presented with three sections consisting of a total of 24 multiple-choice and short-answer questions. Section 1 of the survey included general questions regarding the surgeon's age, years in practice, number of facelifts performed during the surgeon's career, and board certification. Section 2 consisted of questions specific to the 19 month study period (January 1, 2011 to July 31, 2012). Questions included number of facelifts performed with or without ancillary procedures, average operative time for facelifts with and without ancillary procedures, frequency at which surgeries exceeded 4 or 5 h, facelift surgical techniques, and use of benzodiazepine and pain medication. Section 3 consisted of questions regarding number of DVT and PE events over the 19 month study period as well as prophylaxis strategies employed.

Physicians who indicated having one or more patients sustain a DVT or PE were presented with an additional 10-question section for each reported VTE event. Questions included age and gender of the patient, length of the specific operation, prophylaxis used, clinical findings, diagnostic tests, and patient recovery. A comment box was also provided for the responder to provide further details of the event if so desired.

Survey results were anonymously collected by Survey Monkey® over a 1 month data collection period. Nonresponse to the survey by the surgeons was tracked throughout the month, and nonresponding surgeons were sent daily email reminders from Survey Monkey® until their survey was complete. Data were obtained from Survey Monkey® at 1 month and organized on Excel spreadsheets. Fisher's exact test (FET), Pearson's χ^2 test, Pearson's correlation, and two-tailed Student t test were used when appropriate to determine statistical significance. SPSS 19.0 (IBM, Armonk, NY) was used for all statistical analyses.

Results

Eighty-three facelift surgeons were employed and practiced at 41 national Lifestyle Lift centers as of August 2012 and were sent email invitations to respond to the online survey. Seventy-seven completed surveys were returned within the 1 month data collection period for a response rate of 93 %. Two incomplete surveys were excluded from the study, and four surveys were not returned. Three responding surgeons with complete surveys reported that they did not perform any facelift surgeries during the 19 month study period. These surgeons' responses were excluded from this study; thus, all data presented and analyzed are specific to the 74 surgeons with complete surveys and who reported at least one facelift surgery during the study period. Fifty-seven surgeons (77 %) filled out the survey within 20 min.

The mean age of the surgeons was 49.8 years and mean years in practice since completion of training was 16.3 years. Seventy-one of the 74 (96 %) surgeons were board certified and 25 (34 %) were double board certified. The mean estimated number of total facelifts performed in the surgeons' careers was 1,278. However, this value varied greatly across surveys as surgeons reported between 30 and 6,000 career facelifts (Table 1), with a median of 900 career facelifts.

For the 19 month study period, surgeons reported an estimated total of 29,219 facelift surgeries, with or without other facial ancillary procedures, performed specifically under local anesthesia with oral anxiolysis while at Lifestyle Lift, or an average of 395 surgeries per surgeon during the study period ($\sim$249 facelifts per year). Average surgical time reported for completion of a facelift alone was 113 min (1 h 53 min), and average total operative time (skin-to-skin, facelift and any concurrent ancillary procedures) was 157 min (2 h 37 min) (Table 1). Thirty surgeons (41 %) indicated that they never performed a surgery that exceeded 4 h (for facelift and ancillary procedures), and 58 (78 %) indicated they never had a procedure exceed 5 h (Fig. 1). Overall, responding surgeons reported a low frequency of operative times that exceeded 4 or 5 h (Fig. 1).

Thirty-nine (53 %) surgeons reported utilizing SMAS plication more than 70 % of the time, 30 (41 %) reported utilizing imbrication/SMASectomy more than 70 % of the time, and 6 (8 %) reported using the deep-plane/high-SMAS technique more than 70 % of the time. Sixty-five (88 %) surgeons reported that they performed submental liposuction in more than 70 % of their facelifts, and 39 (53 %) surgeons reported that they performed submental liposuction in all facelifts. Ten (14 %) surgeons reported utilizing laser lipolysis for submental reduction all the time

Table 1 General response summary ($n = 74$)

	Range	Mean	SD
Surgeon age	34–71	49.8	10.2
Years in practice since completion of training	3–39	16.3	10.5
Career facelifts performed	30–6,000	1,278.2	1,311.0
Facelifts performed in 19 months	1–1,000	394.9	312.6
Average time for facelift only (min)	60–150	112.7	35.9
Average time for facelift and ancillary procedures (min)	80–300	156.6	46.3

and 51 (69 %) reported never utilizing laser lipolysis. Thirty-two (43 %) reported performing direct fat excision more than 70 % of the time, 13 (18 %) all the time, 25 (34 %) less than 10 % of the time, and 16 (22 %) never. Fifty-two (70 %) reported making the submental incision (>2 cm) for platysmaplasty access more than 70 % of the time and 28 (38 %) all the time.

Sixty-nine (93 %) surgeons gave their patients oral diazepam for anxiolysis. For these surgeons, the mean diazepam given for a procedure was 17 mg. Thirty-five (47 %) surgeons provided diazepam alone, while 34 (46 %) indicated use of diazepam combined with an additional shorter-acting benzodiazepine (lorazepam, alprazolam, or triazolam) (Table 2; Fig. 2). With respect to the pain medication, 54 (73 %) surgeons indicated providing hydrocodone for their patients pre- or intraoperatively. Forty-three (58 %) provided only hydrocodone to their patients and 11 (15 %) indicated that they provided hydrocodone in combination with other pain medication (oxycodone, codeine, Demerol, and/or celecoxib). Seventeen (23 %) responded that they did not provide pain medications pre- or intraoperatively (Table 3).

Surgeons were asked about how frequently they used various VTE prophylaxis methods. Eleven (15 %) reported occasional use of TED hose and/or an intermittent compression device (ICD) and 3 (4 %) reported frequent use of TED hose and/or ICD. Sixty (81 %) indicated they never used TED hose or an ICD for DVT prophylaxis during facelift surgery under local anesthesia.

Five surgeons reported having a patient experience a VTE event over the 19 month study period (Table 4). Four each reported one DVT event postoperatively, and one surgeon reported one DVT that had progressed into a PE. One of the surgeons who reported a DVT indicated that the patient had undergone an orthopedic procedure but did not give any details regarding the procedure, including when it was performed relative to the facelift (Table 4). All five surgeons reported that they never used ICD for prophylaxis, and two reported occasional use of TED hose. One surgeon whose patient sustained a DVT specifically

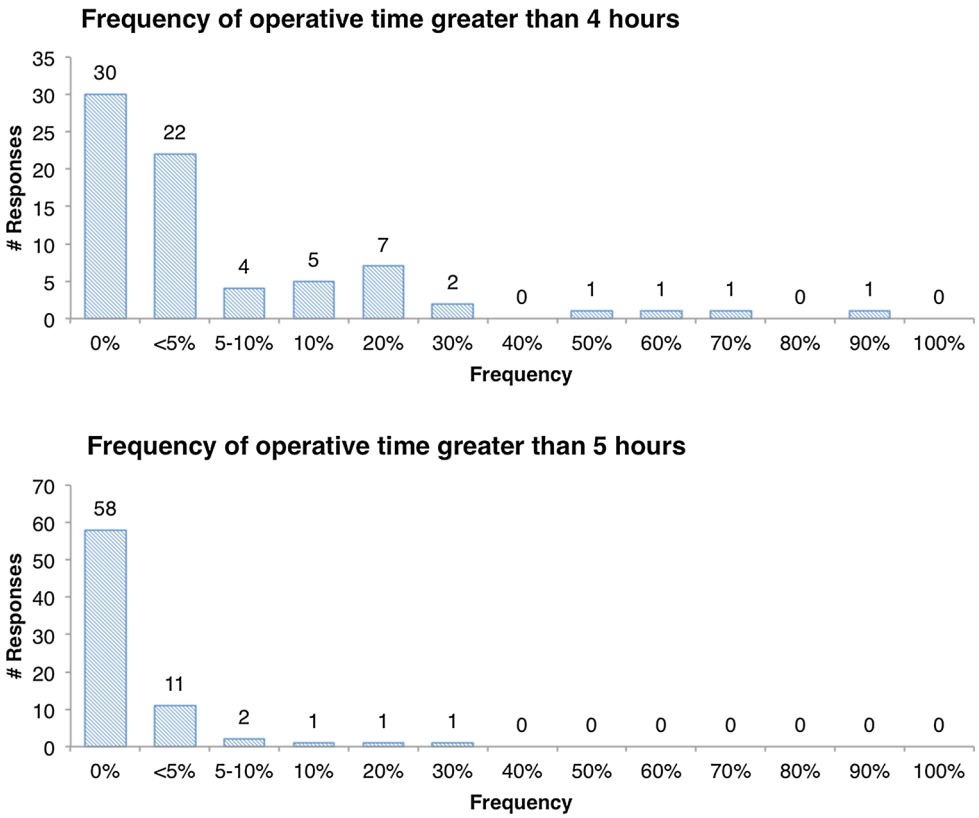

Fig. 1 Summary of reported frequency of long operative times

Table 2 Reported administration of benzodiazepines pre- and intraoperatively

Benzodiazepine combination	Responses	
	No.	%
Diazepam only	35	47.3
Diazepam and other	34	45.9
Diazepam and lorazepam	26	35.1
Diazepam and alprazolam	3	4.1
Diazepam, lorazepam, and triazolam	2	2.7
Diazepam and triazolam	1	1.4
Diazepam, alprazolam, and triazolam	1	1.4
Diazepam, alprazolam, and lorazepam	1	1.4
Lorazepam only	1	1.4
Lorazepam and triazolam	1	1.4
Lorazepam and clonazepam	1	1.4
Triazolam only	1	1.4
Alprazolam only	1	1.4
Total	74	100

Table 3 Reported administration of pain medication pre- and intraoperatively

Pain medication combination	Responses	
	No.	%
Hydrocodone only	43	58.1
Hydrocodone and other	11	14.9
Hydrocodone and oxycodone	7	9.5
Hydrocodone and tramadol	2	2.7
Hydrocodone and demerol	1	1.4
Hydrocodone and celecoxib	1	1.4
Oxycodone only	2	2.7
Codeine only	1	1.4
None	17	23.0
Total	74	100

described use of TED hose because of the patient's reported history of a previous DVT. No responding surgeons reported more than one patient having a VTE event. The ratio of VTE events to facelift surgeries was 1:5,844 for an incidence rate of 0.017 %.

We compared several variables for the facelift surgeries that resulted in a VTE event and surgeries that did not (Table 5). For facelifts that resulted in a VTE event ($n = 5$), the average number of facelifts reported for the 19 month study period by the physicians who performed

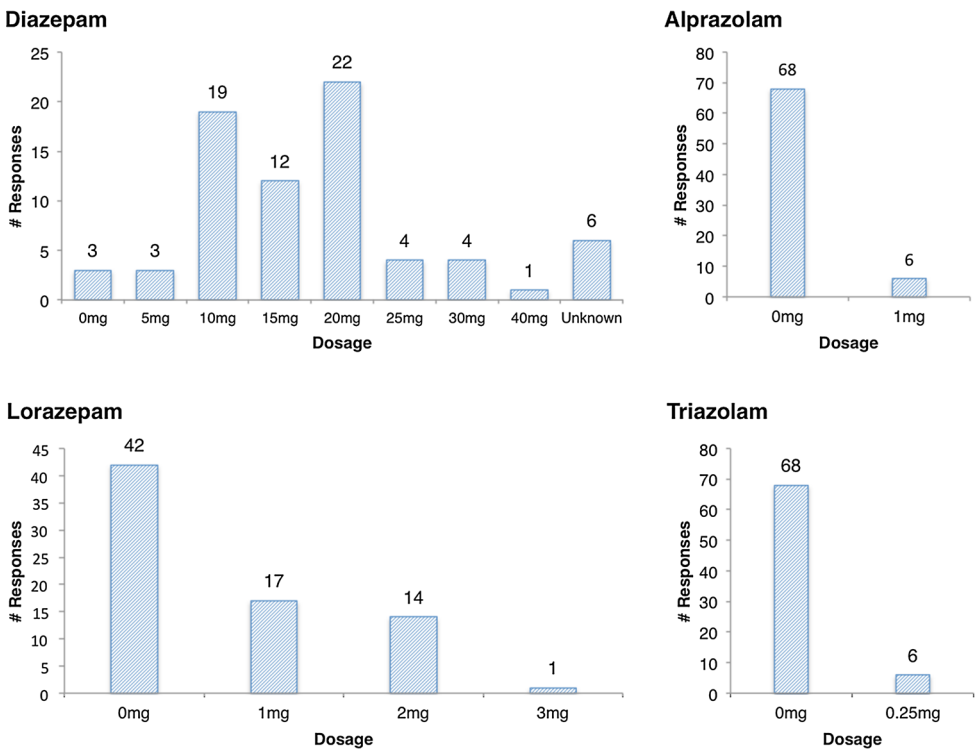

Fig. 2 Summary of reported average individual benzodiazepine dosage

the procedures was 405. For facelifts that did not result in a VTE event ($n = 29{,}215$), the average number of facelifts reported was 639. An independent Student t test indicated a significant difference ($p = 0.036$). No statistical difference was found between other variables in this study, including physician age, years in practice, number of facelifts performed throughout the surgeon's career, operative time, benzodiazepine amount, and pain medication use (Table 5).

Additionally, analysis of surgical volume and VTE incidence was performed. Surgeons were separated into groups based on the number of facelift surgeries reported for the study period (Table 6). VTE incidence showed a decreasing trend with increasing surgical volume (Fig. 3). We then compared the incidence of VTE events in "low-volume" and "high-volume" surgeons. Surgeons were divided into "high volume" (more than 500 facelifts in the 19 month period) and "low volume" (500 or fewer). Forty-six responding surgeons were considered "low-volume" and 28 "high volume." Although high-volume surgeons performed 72 % of facelifts reported in this study, the high-volume surgeons reported only one incidence of VTE (1 VTE for 20,905 surgeries) and the low-volume surgeons reported four of the five VTEs (1:8,314) (Table 7). Comparison between high-volume and low-volume groups indicated a significant difference in VTE incidence ($p = 0.011$).

There was also a statistical difference in reported operative time between high- and low-volume surgeons ($p = 0.016$). The average operative time to perform a facelift with or without ancillary procedures for low-volume surgeons (<500 facelifts in 19 months) was 165 min (2 h 45 min), and for high-volume surgeons (>500 facelifts in 19 months) it was 139 min (2 h 19 min) (Fig. 4). This follows the general trend that operative time decreases with increasing number of facelift surgeries performed (Fig. 5).

Discussion

Local Anesthesia and VTE

This is the first large-scale survey evaluation of VTE incidence in facelift surgery performed strictly under local anesthesia. Only five VTE events were reported in this survey series of 29,219 facelifts (0.017 %, or 1 event in 5,844 surgeries), which is lower than past VTE incidences reported in facelift surgery [1, 24]. Direct comparison of the incidence rate in this study with that reported in the literature should be made with care due to major differences in study cofactors such as type of concurrent ancillary procedures. Nonetheless, the incidence of VTE in this series is felt to be low and there are several likely explanations. First, local anesthesia is a well-established factor for low VTE incidence and in this series the facelifts performed adhered to a strict local anesthesia protocol. Abboushi et al. [1] evaluated VTE incidence for facelifts done with or without ancillary procedures under general anesthesia only in a single-center retrospective chart review of 630 patients over a 7 year period and found a DVT incidence of 0.32 % or one event in 350 surgeries. In a similar large-scale retrospective survey study of facelift surgeons, Reinisch et al. [24] reported a significantly lower VTE incidence in surgeries performed under "IV sedation/local" anesthesia (1 event in 702 surgeries) than under general (1:105). Minimal sedation and utilization of local, rather than general, anesthesia allows the supine patient to move extremities and contract muscles throughout the duration of the surgery, minimizing venous stasis and blood pooling in lower extremities. Local anesthesia also promotes the vascular tone and natural muscle contraction processes that propel venous blood back to pulmonary circulation. Even when attempting to lie very still, muscle tone will continue to promote blood movement through the

Table 4 Summary of reported VTE events

	Gender	Age	Operative time (min)	Prophylaxis	Clinical findings	Tests performed	Patient outcome	Additional notes
DVT 1	Female	60	110	None	Unknown	Unknown	Outpatient treatment, full recovery	
DVT 2	Female	43	165	Other ("early ambulation")	Calf pain, shortness of breath, leg swelling	Positive duplex scan, CT of chest	Outpatient and inpatient treatment (no ICU), full recovery	
DVT 3	Female	70	120	TED hose	Leg swelling	VQ scan	Full recovery	History of DVT
DVT 4	Female	60	210	None	Calf pain	Unknown	Outpatient treatment	"Orthopedic procedure"
DVT/PE 1	Female	55	120	None	Shortness of breath	Unknown	Full recovery	

Table 5 Comparison of surgeries that resulted in VTE and surgeries that did not result in VTE

	VTE ($n = 5$)			No VTE ($n = 29{,}215$)			
	Mean	SD	No. (%)	Mean	SD	No. (%)	*p*
Physician age	43.4	9.91		49.4	9.94		0.176
Years in practice	11.0	10.65		16.1	10.32		0.266
Career facelifts	1,640.0	1,045.47		2,035.2	1,431.4		0.537
19 month facelifts*	405.0	284.72		639.0	250.12		0.036*
Operative time							
Facelift only (min)	87.0	19.87		99.8	29.67		0.335
Facelift + ancillary procedures (min)	145.0	42.13		139.9	39.93		0.775
Operative time over 4 h (%)	3.2	4.09		5.5	11.83		0.683
Operative time over 5 h (%)	0.60	1.342		1.2	4.20		0.743
Benzodiazepine dosage							
Diazepam (mg)	16.0	5.48		15.7	7.68		0.941
Alprazolam (mg)	0.20	0.447		0.08	0.278		0.352
Lorazepam (mg)	0.40	0.548		0.72	0.859		0.257
Triazolam (mg)	0.00	0.000		0.02	0.070		0.49
Pain medication use							
Hydrocodone			2 (40)			20,087 (68.8)	0.185
Oxycodone			2 (40)			2940 (10.1)	0.082
Codeine			0 (0)			28 (0.1)	1

* Two-tailed Student's *t*-test, $p < 0.05$

Table 6 Surgeon volume (grouped by facelifts performed in 19 months) and corresponding VTE incidence

	1	2	3	4	5	6	7	8	
Surgeon volume	1–125	126–250	251–375	376–500	501–625	626–750	751–875	876–1000	Total
Surgeons, no. (%)	22 (30)	10 (14)	8 (11)	6 (8)	8 (11)	5 (7)	9 (12)	6 (8)	74 (100)
Total facelifts, no. (%)	1,155 (4)	1,853 (6)	2,582 (9)	2,724 (9)	4,680 (16)	3,350 (11)	7,275 (25)	5,600 (19)	29,219 (100)
VTEs, no. (%)	1 (20)	1 (20)	1 (20)	1 (20)	0 (0)	0 (0)	1 (20)	0 (0)	5 (100)
Incidence, %	0.0 87	0.054	0.039	0.037	0	0	0.014	0	0.017

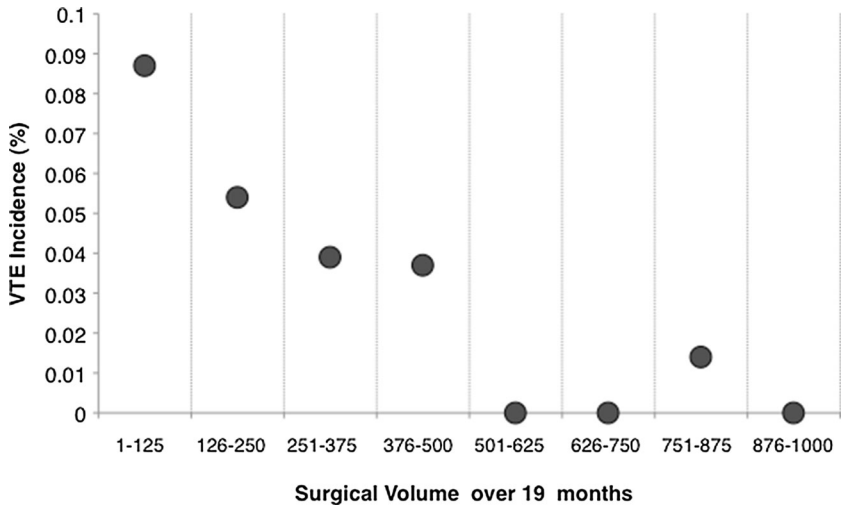

Fig. 3 VTE incidence by surgeon volume (by number of facelifts performed) over 19 month study period

Table 7 DVT incidence for "high-volume" and "low-volume" surgeons

	"Low-volume" surgeons		"High-volume" surgeons	
No. of facelifts (%)	8,314	(28)	20,905	(72)
No. of VTE (%)	4	(80)	1*	(20)
Rate (VTE:FL)	1:2078.5		1:20,905	

* Pearson's χ^2 analysis, $p = 0.011$

extremities more quickly than when under general anesthesia [18].

ASA Level 1 Anesthesia, Anxiolysis

Surgeons in this series also provided only oral anxiolysis and not IV or general anesthesia to patients who underwent a facelift. According to the ASA, level 1 anesthesia indicates "minimal sedation," or anxiolysis, whereby patients maintain important physiologic reflexes and functions and the ability to respond normally to verbal commands [2]. Minimal sedation allows for some intraoperative patient movement and also allows for the patient to ambulate immediately prior to and after the procedure. In 2000, Gatti [8] reported the successful application of the combination oral benzodiazepine technique for 372 cosmetic surgery patients, noting sufficient patient perioperative comfort without significant concern for oversedation. Table 2 summarizes the amounts of benzodiazepine anxiolysis provided for facelift patients in this series. Facelift patients respond in different ways to oral benzodiazepines, and different patients require different dosages to achieve comparable levels of anxiolysis. Careful titration of medications ensures the appropriate level of anxiolysis and

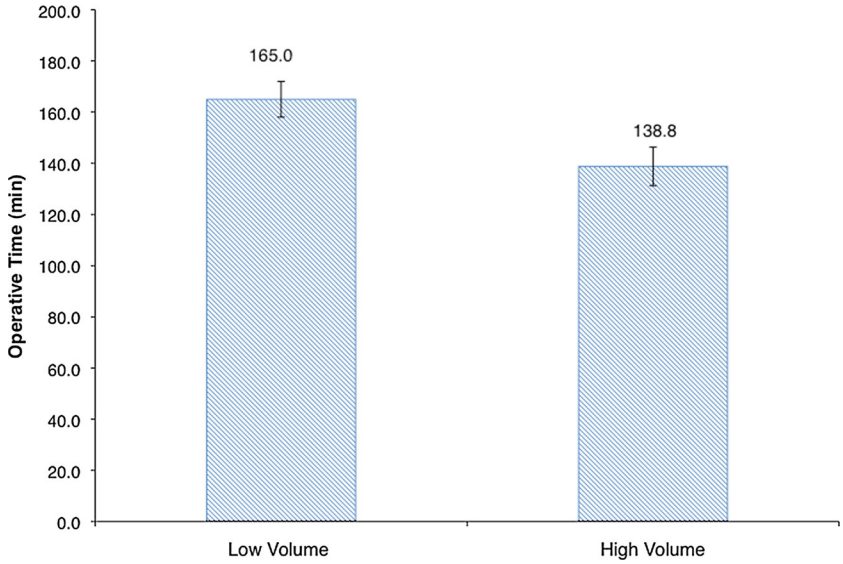

Fig. 4 Average reported operative time (for facelift with or without ancillary procedures) for "high-volume" and "low-volume" surgeons. *Error bars* indicate standard error

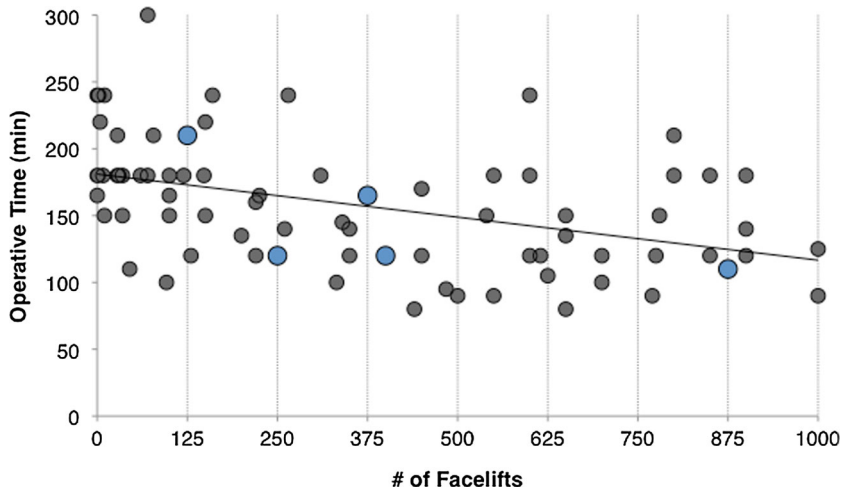

Fig. 5 Surgeon-reported average operative time by number of facelifts performed over the 19 month study period. *Blue points* indicate surgeons who reported a VTE event

prevents deeper levels of sedation. In our experience, the average levels of benzodiazepines indicated in this survey are rarely associated with moderate or deep sedation.

Operative Time

In addition to the use of local anesthesia, the short average operative time reported in this series is also likely a major contributing factor to the low VTE incidence observed. With shorter operative times, extremity mobility restriction is minimized and patients are able to resume ambulation sooner, minimizing venous stasis. Interestingly, operative times reported for the five specific surgeries that resulted in a VTE event were not significantly longer than the surgeons' reported average operative times, and none exceeded 4 h (Table 4). The mean reported average operative time of the surgeons who performed the surgeries that resulted in VTE also was not significantly greater than the average operative time of surgeons who performed surgeries that did not result in VTE (Table 5). However, in this series, the mean average operative time for a facelift and ancillary procedures was 157 min (2 h 37 min), and the number of surgeries that took longer than 4 h was limited, with even fewer surgeons reporting ever having operative times exceeding 5 h. In their survey study, Reinisch et al. [24] reported an average operative time of 285 min (4 h 45 min), and in a single-center retrospective chart review, Abboushi et al. [1] reported an average operative time of 256 min (4 h 16 min). In both studies, longer operative times were noted for the procedures that led to a VTE event (>5 h), suggesting that longer operative time in facelift surgery, particularly under general anesthesia, increases the risk for embolism. This is also consistent with studies of VTE incidence and operative time in other surgeries such as hip arthroplasty [27], neurosurgery [29, 31], and general surgery [5].

In Abboushi et al.'s report [1], however, more time-consuming ancillary procedures such as abdominoplasty and breast augmentation were often performed concurrently with a facelift. Factors that contributed to the low operative times reported in our series are the type and number of ancillary procedures performed in conjunction with facelift surgery. In our series, surgeons performed only short-operative-time minor facial rejuvenation ancillary procedures (blepharoplasty, fat grafting, fractionated CO_2 laser, chin implant, and browlift) concurrent with the facelift. Abboushi et al. [1] reported two DVT events following facelift surgery in their series, both of which followed operations that included one concurrent ancillary procedure. The most common ancillary procedures indicated in Abboushi et al.'s study were rhinoplasty, liposuction, and abdominoplasty. Abdominoplasty surgery alone has a high VTE incidence, but the incidence rate increases several fold when combined with other procedures [4, 11, 12, 23, 32]. Reducing or eliminating the number of major ancillary procedures done concurrently with a facelift, such as abdominoplasty, may help lower the incidence of VTE. Surgeons should consider both the risk associated with the patient's desired ancillary procedures and the increase in operative time when planning for a safe facelift surgery.

However, the type of ancillary procedure does not entirely explain the shortened operative time in this series. A total of 76.4 % of surgeries performed in the Abboushi et al. series were facelift only, i.e., without any ancillary procedures. Excluding any ancillary procedures, in this series the average surgical time for a facelift only was low (1 h 53 min). From a survey on facelift techniques, Matarasso et al. [19] reported that only 4 % of surgeons reported an operative time for a facelift of less than 2 h. Thus, there are likely additional factors beyond the type of ancillary procedures performed that contribute to the low average facelift operative time reported in this series.

It is not felt that a limited dissection or limited platysmaplasty facelift techniques accounted for the lower operative times in our series. The majority of surgeons (90 %) surveyed are board certified ABPS, ABFPRS, or ABOHNS. As such, these surgeons use their own discretion from their training and experience to guide them as to the best facelift technique for each individual patient to achieve appropriate rejuvenation. Reported facelift techniques varied but are similar to the techniques and types of facelifts indicated in previous surveys. A submental incision and platysmaplasty was performed by 70 % of surgeons 70 % of the time, indicating a more comprehensive treatment of neck aging changes in the majority of patients. In Matarasso et al.'s [19] national plastic surgeon survey of facelift techniques , 19 % indicated using SMASectomy, 42 % imbrication, and 9 % a composite or deep-plane technique, whereas in this series, 41 % indicated frequent (more than 70 % of the time) SMASectomy/imbrication, 39 % indicated plication, and 8 % indicated deep-plane techniques, which are similar to the numbers of Matarasso et al. A high percentage in Matarasso et al.'s [19] study also addressed submental fat: 60 % indicated direct fat excision when addressing submental fat and 27 % performed suction-assisted lipectomy. In our survey, more surgeons (88 %) indicated use of liposuction frequently in addressing submental fat, but many also indicated using direct fat excision frequently (43 %). Thus, the surgical facelift techniques indicated in this survey are comparable to those of past studies and reflect the different trends in today's facelift techniques.

High Surgical Volume

Patients who did not sustain a VTE in this series had surgeons who, on average, performed a statistically greater number of facelifts during the 19 month period than the

surgeons of patients who did sustain a VTE ($p = 0.036$, Table 5). Surgeons who performed more than 500 facelift procedures in the 19 month study period (~316 facelifts per year) reported only one VTE in 20,905 facelifts (0.005 %), while surgeons who performed fewer than 500 facelift procedures reported 4 VTEs (0.05 %), an incidence of 1 event in 2,078 facelifts (Table 7). This distribution of VTE events between high- and low-volume surgeons was statistically significant ($p = 0.011$). Previous studies on specific surgical procedures, especially high-risk and high-mortality procedures such as abdominal aortic aneurysm surgery [15] and pancreatic resection surgery for cancer [10, 13], have shown that surgeons and hospitals with greater surgical volume tend to have better outcomes compared to lower-volume counterparts. Less research exists on volume-outcome studies in facelift surgery, but our study shows a similar pattern of "practice makes perfect," where the practice involves high-frequency and high-volume output of a single procedure or group of procedures.

In a survey of prophylactic strategies in plastic surgery, Broughton et al. [4] also examined VTE incidence by the number of facelift operations surgeons performed per year. They did not find a statistically significant difference between surgeons who performed 11–20 facelifts a year and surgeons who performed 41–50 facelifts a year [4]. Our study surveyed surgeons with a wider range of surgical operative volume. It is common knowledge that any surgical procedure or skill has a learning curve and requires a certain amount of practice before becoming proficient at it. However, our data suggest that beyond the initial learning curve, operating at a very high frequency of about 316 facelifts or more a year, 8–13 times greater than the average rates reported in past surveys of facelift surgeons [19, 24] and over 6 times greater than the highest-volume surgeons in Broughton et al.'s study [4], results in a significantly lower incidence of VTE events. Thus, there appears to be a trend whereby the incidence of VTE decreases with increasing surgical volume and proficiency (Fig. 3).

The average reported operative times for the five surgeries that resulted in VTE were not statistically longer than the surgeons' typical reported operative times, and the average operative time of the surgeons who performed surgeries that resulted in a VTE was not significantly greater than the average operative time of surgeons who performed surgeries that did not result in a VTE. However, the average reported operative time for high-volume surgeons was significantly lower than the average time for their low-volume counterparts (Fig. 4). This points to the possibility that surgeons who operate very frequently are more familiar with the anatomy of and thus more efficient with facelift procedures, cutting down on operative time. Having an outpatient center where equipment is streamlined for facelift surgery and having a surgical team that is also experienced in and specialized toward performing facelift procedures further improves upon surgical efficiency. These differences in overall efficiency and average operative time may be contributing factors to the difference in VTE incidence since high-volume surgeons in this series had statistically fewer VTE events. Since the responding surgeons in this study on average reported performing facelifts at a high frequency, this may be a major contributing factor to the low average operative time reported in this series. However, more comprehensive study is needed to better characterize the impact of surgical volume and operative time on VTE incidence.

VTE Prophylaxis

It has been well established that prophylaxis decreases the risk of VTE in high-risk surgeries mostly done under general anesthesia and with long operative times [6, 21, 25, 26, 28, 33]. Reinisch et al.'s study [24] showed that surgeons who used ICD during facelift surgery reported statistically fewer VTEs than surgeons who did not report any use of prophylaxis. Surgeons in our survey reported low use of ICD for VTE prophylaxis, but there were only five cases of VTE overall. In this survey, the individual surgeons' decisions not to use VTE prophylaxis were likely influenced by the knowledge that using local rather than general anesthesia decreases VTE risk. Understandably, all surgeons should exercise good judgment when making the decision to use prophylaxis as VTE events are generally underdiagnosed and frequently result in severe consequences.

Although responding surgeons did not report high use of TED hose or ICD for VTE prophylaxis, surgeons did comment that they encouraged stretching exercises intraoperatively and early ambulation postoperatively as prophylaxis strategies. Stretching and early ambulation reduce venous stasis and may be sufficient prophylaxis for patients evaluated as at low risk for VTE and are undergoing short procedures under local anesthesia.

VTE Risk Factors

In a UK survey of VTE prophylaxis in oral and maxillofacial surgery, the risk factors considered most common by surgeons were past VTE, prolonged immobilization, length and magnitude of the operation, and age and weight of the patient [7]. A number of risk-assignment prophylaxis protocols have been described and they recommend that surgeons take into account these common risk factors [16, 21, 22, 26]. Surgeons should assess a patient's possible elevated risk for VTE prior to any facelift surgery, and the

appropriate prophylactic steps should be taken perioperatively to minimize risk for all facelift patients.

One physician in our series who reported a DVT commented that the patient had a history of DVT (Table 4). A previous VTE event is a significant risk factor for future incidence of VTE [3]. Thus, it is important for surgeons to note any patient history of VTE prior to surgery and carefully consider the elevated risk before performing any elective surgery. Greater caution should also be considered for patients who present other significant risk factors for VTE such as recent major surgery. Another patient in this series who sustained a DVT had undergone an orthopedic procedure around the same time as the facelift (Table 4). Extra precautions should be used for patients who have had recent major surgery, including prophylaxis and consideration of separating the surgeries by several weeks and waiting until complete recovery is achieved from the first surgery.

Patient age is also a factor to be considered prior to performing a facelift. Although the survey by Reinisch et al. [24] found no significant difference in the age of patients who did and did not sustain a VTE in their facelift survey, other studies of VTE risk factors have shown that patients over the age of 40 are at an increased risk of sustaining a VTE and that this risk doubles with each subsequent decade [3, 21]. Individuals over 40, and usually over 50, are the primary candidates for facelift surgery, and all the patients who sustained a VTE in this survey were over the age of 40 (Table 4).

VTE Underreporting and Selection Bias

Underreporting and selection bias are significant concerns in survey studies on the incidence of complications. Throughout the month of survey collection, surgeons with incomplete surveys were sent email reminders to complete the survey. We had a high response rate (93 %), which greatly minimizes the concern for selection bias. As reluctance to report a complication is a limitation of survey studies, our survey was anonymous so as to achieve the most accurate assessment of incidence. The fact that the survey was anonymous and would be used strictly for research purposes was emphasized to the surgeons in the survey instructions, reminder emails, and within the survey itself. All five VTE events in this series were reported within the first three days of survey collection, before any significant email follow-up had been sent to nonresponders. This suggests minimal reluctance to report personal experiences with VTE complications. Furthermore, the legal and patient relations group departments and the medical directors, who oversee the physicians at Lifestyle Lift centers, are alerted to complications such as VTE. Limited anecdotal accounts of VTE-related incidence from the legal, patient's relation group, and medical directors of Lifestyle Lift confirm the finding of low VTE incidence reported in this survey.

However, it is important to note that postoperative DVT and PE incidence is difficult to measure accurately, particularly on an outpatient basis. It is estimated that two-thirds of DVT and PE events exhibit no symptoms [33], and the primary surgeon may not learn about a postoperative VTE event if the patient chooses not to return for a scheduled follow-up after an operation. The actual incidence rate of VTE events in this study is most likely higher than the reported rate, and thus facelift surgeons should not underestimate the risks of VTE events even when utilizing local anesthesia and operating under 4 h.

Like previous plastic surgery surveys [4, 12, 20, 24], this series has limitations because the data depend on the memory of the surgeon. Physicians may tend to overestimate the number of surgeries they performed and underreport the number of complications experienced. However, it is felt to be a reasonable assumption that a surgeon will not forget a VTE event that occurred within the previous 19 months, and that the surgeon trusts that the survey is anonymous and therefore will be forthcoming with honest information. However, additional details such as exact operative time, ancillary procedures performed along with the facelift, and the exact ages of the patients would require a more comprehensive chart review. The reliance on the accuracy of the surgeon's memory is a limitation of this survey and previous similar facelift surveys.

While the anonymous nature of our survey was important in maximizing surgeon response, this also presented additional challenges. Most questions presented in the survey were multiple choice or short answer, and while some questions included comment boxes for further elaboration, compliance was entirely dependent on the physicians' willingness to provide additional information. This was most important for the VTE event section of the survey that was presented to responders who reported a VTE event. Questions were designed to maximize responder compliance, asking the responder to provide general information from memory about the event. As a result, some points about the event may have been described in less detail than desired. For instance, the responding surgeon of the patient with DVT 4 did not indicate full patient recovery and indicated the patient had had recent orthopedic surgery (Table 4). Further details regarding this procedure were desired. In general, further details about the patient's VTE diagnosis and recovery would also be ideal. However, the anonymous nature of the survey prevented us from performing further follow-up. Because of the limitations noted above, further studies in facelift surgery are needed to confirm VTE incidence and the impact of relevant risk factors.

Our study represents a unique data set of facelift patients. Unlike past reports, facelift procedures are performed strictly under local anesthesia, with concurrent procedures limited to the face, by surgeons who on average perform a high number of facelifts each year. On the other hand, we believe that our patient group is representative of the average patient who desires facial rejuvenation. We were not able to examine individual patient information and history due to the limited nature of the survey. However, the average age of our patients, according to 2008 company statistics, was 59.5 years. This is similar and slightly higher than the average patient ages reported by Reinisch et al. (54.8 years) and Abboushi et al. (58.4 years). Furthermore, the physicians surveyed in this study practice in multiple centers throughout the US, which likely minimizes geographical selection factors such as culture and socioeconomic status. However, a limitation of survey studies is that we cannot comprehensively review the patients and procedures included in this series. Because of this, direct comparisons between the rates of VTE reported in the literature and the rate in our study are difficult to make. Thus, while VTE incidence is lower than previously reported incidences for facelift, a controlled study is needed to examine the relationship between VTE and specific variables unique to our study.

Conclusion

The results of this series support prior knowledge that local anesthesia with oral anxiolysis rather than general or intravenous anesthesia and shorter operative time reduce VTE incidence. The VTE rate is lower in this series than previous reports of VTE after facelift surgery performed under general anesthesia or under local and IV sedation, and strict adherence to a local anesthesia protocol, short average operative times, and limited length of ancillary procedures may be contributing factors. However, further controlled studies are needed to examine these factors in relation to VTE incidence. High-volume surgeons have a lower incidence of VTE complication and a shorter average operative time than their lower-volume counterparts, and there is a trend of decreasing VTE incidence with greater surgical volume. Overall, the incidence of VTE for facelifts performed under local anesthesia is 1 in 5,844 but is as low as 1 in 20,905 for high-volume surgeons who performed more than 500 facelifts in 19 months. Surgeons should consider planning facelift surgery for less than 4 h and staging procedures if the operative time is anticipated to exceed 4 h. Early ambulation and stretching exercises immediately after surgery may suffice for VTE prophylaxis when utilizing local anesthesia, particularly when performed by high-volume surgeons with low operative times on patients with limited VTE risk factors.

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