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Body Contouring in Massive Weight Loss Patients Receiving Venous Thromboembolism Chemoprophylaxis: A Systematic Review

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Background: Venous thromboembolism (VTE) events are the leading cause of morbidity and mortality in plastic surgery. Currently, there is no consensus regarding the use of VTE chemoprophylaxis in the context of the risk for bleeding following specific body contouring procedures. Furthermore, there is increasing popularity of these procedures in the massive weight loss (MWL) patient population, who may be at higher risk due to multiple risk factors. The purpose of this study was to stratify the incidence of VTE and bleeding events among individual, specific body contouring procedures in MWL patients receiving chemoprophylaxis.
Methods: A systematic review was designed according to PRISMA guidelines. We screened all articles published between 1988 and 2018 reporting chemoprophylaxis status, VTE, and bleeding events in MWL patients undergoing body contouring procedures.
Results: Thirty-one publications were reviewed. The VTE incidence for any procedure was too low to reach significance. Overall, hematoma incidence in single-procedure patients (8.7%) was significantly higher than concomitant-procedure patients (4.2%, $P < 0.01$). However, when stratified into operative and nonoperative hematomas, no significant difference between single- and concomitant-procedure groups overall was demonstrated for either category. Individually, only thighplasty patients had a higher rate of operative hematomas when undergoing thighplasty alone (5.3%) compared with thighplasty with concomitant procedures (0.6%, $P < 0.05$).
Conclusions: Overall, MWL patients undergoing single body contouring procedures (among abdominoplasty, belt lipectomy, thighplasty) were found to have a higher risk of hematoma compared with those undergoing combined contouring procedures. However, stratified hematoma data revealed no differences in overall risk between single- and multiple-procedure operations. *(Plast Reconstr Surg Glob Open 2021;9:e3746; doi: 10.1097/GOX.0000000000003746; Published online 13 August 2021.)*

INTRODUCTION

Venous thromboembolism (VTE) events are the leading cause of morbidity and mortality in plastic surgery.[1] Concomitant surgeries, reconstruction type, increased operative times, previous bariatric surgery, and obesity are all known risk factors for VTE events.[2–4]

Many surgeons report bleeding concerns in body contouring patients and cite this as a reason for not using VTE chemoprophylaxis.[2,5] This is underscored by the variable compliance among plastic surgeons with prophylaxis standards set by the American College of Chest Physicians as well as the prior absence of clear evidence-based standards for plastic surgery patients.[5–7] Since then, in 2016, Pannucci et al[8] published a very detailed set of consensus guidelines on weighing the risks and benefits of VTE prophylaxis in plastic surgery, which has benefitted the field tremendously. However, their publication does not offer specific guidance for specific patient populations, such as massive weight loss (MWL) patients.

The MWL population is especially relevant to the field of plastic surgery considering the increasing popularity of

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post-MWL body contouring procedures. These patients may be at higher risk of bleeding events due to residual medical comorbidities, obesity, nutritional deficiencies, and lifestyle factors, thereby highlighting the need for more accurate risk stratification.[9] Most notably, MWL patients often require multiple procedures to address their whole-body deformities, which must be accounted for when deciding on the use of chemoprophylaxis.[10] Although there is mixed evidence, one review suggested that complications in these patients are specific to attributes associated with MWL,[11] because non-MWL patients undergoing combined cosmetic procedures did not experience increased complication rates.[12–14]

The risk of VTE in MWL patients undergoing postbariatric body contouring surgery has been reported to range from less than 1% to 9.3%.[9] A 2011 survey revealed that for postbariatric body contouring surgery, deep venous thrombosis (DVT) occurred in more than one-third of plastic surgeons' practices, with 7% of surgeons reporting lethal pulmonary emboli, further emphasizing the need for chemoprophylaxis.[15] However, the literature disagrees about the risks of bleeding associated with VTE chemoprophylaxis. In body contouring patients receiving enoxaparin, some groups found an increased rate of hematoma,[2,16] whereas others demonstrated a lack of association between enoxaparin prophylaxis and increased bleeding events.[6,17] Furthermore, in 2015, Michaels et al found that routine VTE prophylaxis did not increase the bleeding incidence for the aggregate of body contouring procedures in MWL patients, and in 2009, Coon et al. showed that the number of procedures was unrelated to hematoma incidence.[11,18]

There is a general consensus that different contouring procedures confer different bleeding and hematoma risks, which are mostly associated with abdominal contouring.[11,19,20] Nevertheless, to date, there have been no studies on VTE and bleeding risk when stratified by single, specific body contouring procedures, particularly in the MWL patient population. Therefore, the purpose of this study was to analyze the incidence of VTE and bleeding events in MWL patients who have received VTE chemoprophylaxis and whether these rates are significantly affected by undergoing single versus multiple concomitant body contouring procedures.

METHODS

A systematic review was designed following PRISMA guidelines. The PubMed, Cochrane, and CINAHL databases were queried for original studies. Search terms were chosen to capture the concepts of massive weight loss, bleeding, DVTs, and body contouring procedures. The title and abstract of these studies were reviewed with the authors and institutions blinded. Included studies met all of the following criteria: (1) quantifiable complications in bleeding and VTE specific to the massive weight loss population, (2) quantifiable complications in bleeding and VTE that could be isolated per body contouring procedure, and (3) stated chemoprophylaxis status and regimen. The references of the studies that met inclusion criteria were also analyzed to identify additional studies not captured by the original database query. Excluded studies were case reports, studies with less than 20 subjects, studies where not all of the above criteria were met, and non-English studies. The search protocol and article selection were completed by three contributing authors (CY, JEM, PBM) and cross-reviewed for inconsistencies.

Patient characteristics recorded from each study included number of patients who met the inclusion criteria, patient age, sex, both pre- and postmassive weight loss BMI, and complications, which were stratified into bleeding complications (anemia, hematoma, postoperative transfusion requirements, return to OR) and VTE complications (DVT, PE). Additionally, chemoprophylaxis agent and duration of prophylaxis were recorded.

The data from the included studies were pooled, weighted per patient, and analyzed using SPSS Statistics (IBM Corporation, Armonk, N.Y.) to perform chi-squared, Fisher exact, and independent sample t-tests. Statistical significance was achieved when $P < 0.05$.

RESULTS

Initial search yielded 1970 results (Fig. 1). Title and abstract review resulted in 83 manuscripts that were selected for full review. An additional seven studies were included from a citation review. Thirty-one studies that met the full inclusion criteria of describing quantifiable bleeding and VTE complications for massive weight loss patients undergoing specific body contouring procedures were extracted for data. (**See table 1, Supplementary Digital Content 1**, which displays a summary of all selected publications. Several studies are entered twice because they reported two separate groups of patients that were both relevant to our study. **http://links.lww.com/PRSGO/ B739**.) The type of VTE prophylaxis along with dose and duration of treatment utilized were also recorded but were ultimately too inconsistent to produce a meaningful analysis. (**See table 2, Supplementary Digital Content 2**, which displays a summary of VTE prophylaxis regimen for all selected publications. **http://links.lww.com/PRSGO/ B740**.) VTE risk assessment was not explicitly documented in a vast majority of the selected publications and was therefore excluded from analysis.

The 31 included studies encompassed 2264 massive weight loss patients undergoing body contouring procedures. Overall, the patients had an average age of 42.3 years (n = 987) for those undergoing a single procedure and 43.9 years (n = 1277) for those undergoing multiple procedures ($P < 0.01$). The preoperative BMIs were higher for single procedure patients than for multiple procedure patients (30.7kg/m^2 versus 29.9kg/m^2, $P < 0.01$). The patients were also mostly women, though there were more women who underwent multiple procedures (79.3%) than a single procedure (69.7%, $P < 0.01$). These patients were then stratified based on specific body contouring procedure, and whether a concomitant body contouring procedure was performed at the same time. The resultant cohorts included abdominoplasty, abdominoplasty + concomitant procedure, circumferential lipectomy, circumferential lipectomy + concomitant procedure, thighplasty,
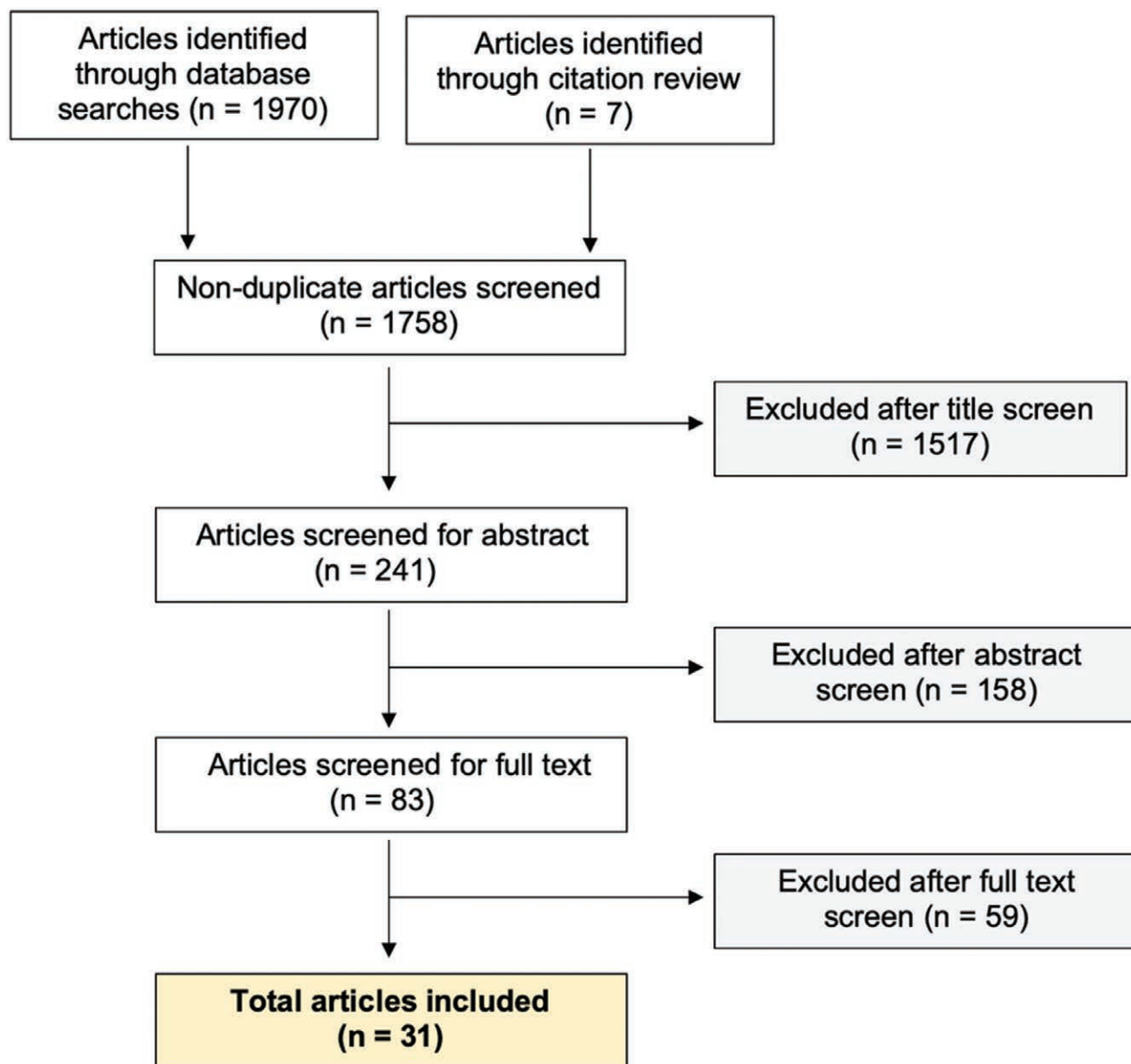
Fig. 1. Schematic of systematic review methodology.

and thighplasty + concomitant procedure. Brachioplasty and mastopexy groups were underpowered (n < 20) and thus were excluded from analysis. Concomitant procedures included liposuction and additional body contouring procedures; however, altogether, the documentation of these additional procedures was not able to be extracted and specifically analyzed per concomitant procedure. The demographic data for the patients in each of these cohorts are represented in Table 1.

Complications involving bleeding and VTE events are represented in Table 2. Overall, the VTE incidence for any procedure, single (n = 987, 0.04%) or multiple concomitant (n = 1277, 0.06%), was too low to reach significance. Hematoma incidence in single-procedure patients (8.8%) was significantly higher than concomitant procedures (5.2%, $P < 0.01$), which appeared to correspond directly with the incidence of postoperative anemia (34.6% versus 5.9%, $P < 0.01$). In contrast, transfusion requirements were significantly higher in the concomitant-procedure group overall ($P < 0.01$).

The incidence of VTE was 0.44% for patients undergoing abdominoplasty alone and 0.48% for patients undergoing abdominoplasty with a concomitant procedure; however, this failed to reach statistical significance. In patients who underwent abdominoplasty alone, the incidence of hematoma was 9.4% (n = 681) compared with 6.2% (n = 1,044) for those who underwent a concomitant body contouring procedure ($P < 0.05$). The incidence of postoperative anemia (41.8% versus 5.9%, $P < 0.01$) appeared to correlate directly with hematoma incidence, but an inverse correlation was observed with blood transfusion requirements ($P < 0.01$). Patients undergoing

Table 1. Summary of Demographic Data of Patients within Selected Publications

Cohort (N = 32)	n	Average Age		Gender (% Women)		Average BMI	
		Years	P	%	P	kg/m²	P
OVERALL	987	42.3		69.7%		30.7	
OVERALL+	1277	43.9	**<0.01**	79.3%	**<0.01**	29.9	**<0.01**
Abdominoplasty	681	42.7	**<0.01**	70.3%	0.307	31.6	**<0.01**
Abdominoplasty+	1044	44.6		72.6%		29.9	
Belt Lipectomy	230	41.2	**<0.01**	62.6%	**<0.01**	29.3	0.397
Belt Lipectomy+	53	38.7		92.5%		29.8	
Thighplasty	76	41.7	0.945	94.0%	0.977	27.5	**<0.01**
Thighplasty+	180	41.6		93.9%		29	

N = number of reporting studies; n = number of patients.
Boldface indicates statistical significance.

Table 2. Summary of Bleeding or Clotting Complications from Selected Publications

Cohort	VTE (N = 34)			Hematoma (N = 34)			Transfusion Required (N = 15)			Postoperative Anemia (N = 5)		
	n	%	P	n	%	P	n	%	P	n	%	P
OVERALL	987	0.04%		987	8.8%		500	7.4%		381	34.6%	
OVERALL+	1277	0.06%	0.472	1277	5.2%	**<0.01**	245	21.6%	**<0.01**	205	5.9%	**<0.01**
Abdominoplasty	681	0.44%	0.909	681	9.4%	**<0.05**	319	0.9%	**<0.01**	285	41.8%	**<0.01**
Abdominoplasty+	1044	0.48%		1044	6.2%		192	17.7%		205	5.9%	
Belt Lipectomy	230	0.43%	**<0.01**	230	8.3%	0.138	155	20.0%	**<0.05**	Not enough data		
Belt Lipectomy+	53	5.66%		53	1.9%		53	35.8%				
Thighplasty	Not enough data			76	5.3%	**<0.05**	Not enough data			Not enough data		
Thighplasty+				180	0.6%							

N = number of reporting studies; n = number of patients; VTE = venous thromboembolic event, which includes DVT or PE.
Boldface indicates statistical significance.

abdominoplasty alone had a higher BMI (31.6 kg/m² versus 29.9 kg/m², $P < 0.01$).

The incidence of VTE in patients undergoing belt lipectomy alone was 0.43%, and this was significantly lower than the VTE incidence in patients undergoing belt lipectomy with concomitant procedures (5.66%, $P < 0.01$). In patients who underwent belt lipectomy alone, the incidence of hematoma was 8.3% (n = 230) compared with 1.9% (n = 53) for those who underwent a concomitant body contouring procedure, though this also failed to achieve significance. Blood transfusion requirements (20.0% versus 35.8%, $P < 0.05$) appeared to correlate directly with VTE incidence in patients undergoing belt lipectomy. There was insufficient data to analyze postoperative anemia. The BMI between patients undergoing belt lipectomy with or without concomitant procedures was not significantly different (29.8 kg/m² versus 29.3 kg/m²).

In patients undergoing thighplasty alone, the incidence of hematoma was 5.3% (n = 76) compared with 0.6% (n = 180) for those who underwent thighplasty and a concomitant body contouring procedure ($P < 0.05$). All cases of hematoma in the thighplasty alone group were reported from one study with 29 patients, which likely represents reporting bias.[21] There were no VTE events captured in the cohort of patients undergoing thighplasty with or without a concomitant procedure; furthermore, there was insufficient data to analyze blood transfusion requirements or postoperative anemia. The BMI of patients undergoing thighplasty alone was 27.5 kg/m², and this was significantly lower than patients undergoing thighplasty and a concomitant body contouring procedure (29.0 kg/m², $P < 0.01$).

Table 3 summarizes the hematoma incidence when stratified into two subcategories: operative and nonoperative hematoma, which was specified by 28 studies. The only statistically significant finding in this analysis was that patients undergoing thighplasty alone had a higher incidence of operative hematoma (5.3%) compared with those undergoing thighplasty with a concomitant

Table 3. Summary of Hematoma Data when Stratified into Operative and Nonoperative Intervention Groups

Cohort (N = 28)	n	Operative Hematoma		Nonoperative Hematoma	
		%	P	%	P
OVERALL	687	1.3%		4.2%	
OVERALL+	1254	1.0%	0.4961	4.4%	0.8771
Abdominoplasty	396	1.0%	1	4.3%	0.4901
Abdominoplasty+	1044	1.1%		5.2%	
Belt Lipectomy	215	0.5%	1	5.6%	0.3706
Belt Lipectomy+	30	0.0%		0.0%	
Thighplasty	76	5.3%	**<0.05**	0.0%	1
Thighplasty+	180	0.6%		0.6%	

N = number of reporting studies; n = number of patients.
Boldface indicates statistical significance.

procedure (0.6%, $P < 0.05$). There was no significant difference in the incidence of nonoperative hematomas among any type of procedures. In contrast, for the overall, abdominoplasty, and belt lipectomy groups, there were generally higher hematoma rates in the nonoperative compared with the operative category; among these groups, there was no significant difference on stratified hematoma incidence between patients undergoing single and concomitant procedures.

DISCUSSION

The massive weight loss patient population inherently carries a higher risk of having complications following surgery due in part to possible nutritional deficiencies, medical comorbidities, and higher BMI compared with traditional body contouring patients.[9] Although there are some published data regarding this population's risk profile in undergoing body contouring procedures, original research stratifying the risk profiles of individual procedures remains to be published. Having this information may allow surgeons and providers to better anticipate complications and educate patients about their overall risk following these procedures.

In our review, there was a significantly higher percentage of women undergoing concomitant belt lipectomy compared with belt lipectomy alone; additionally, overall, a higher proportion of women pursued concomitant over single procedures. The effect of gender on body contouring outcomes has been described previously, and male gender was demonstrated to be an independent risk factor of postoperative hematoma but not wound dehiscence, flap loss, transfusion, or surgical-site infection.[22,23] Therefore, the specific relationship between gender and hematoma risk could bias the results of our study. Still, the proportion of women in our study is within the typical range of most plastic surgery practices and what is presented in the literature, and our results offer important new insights into procedure-specific postoperative bleeding and VTE rates.

The incidence of VTE in our cohorts ranged from 0.04% to 5.7%, which is similar to what has previously been reported in the literature.[9,24] In patients undergoing thighplasty in our review, the incidence of VTE was too low to test for statistical significance. Despite the lower hematoma rate in the thighplasty+ group, it is difficult to ascertain the real risk-to-benefit ratio of VTE chemoprophylaxis for these patients. In patients undergoing belt lipectomy, the rate of VTE was significantly higher in the concomitant procedure group; notably, belt lipectomy is the only procedure yielding no significant difference in BMI, but the differences in BMI in the other groups are likely not clinically significant enough to independently account for our observations.[24] In comparison, the overall and abdominoplasty groups did not have any difference in VTE risk with respect to undergoing single versus concomitant procedures. This finding could be attributed to evidence that an abdominoplasty itself is a risk factor for VTE and may be among the strongest predictors of VTE in body contouring patients.[11,19]

The incidence of hematoma ranged from 0.6% to 9.4%. The higher rate of hematomas in patients undergoing a single compared with multiple procedures overall suggests that single procedures confer increased hematoma risk. However, when stratified into operative and nonoperative hematomas, no significant differences between single and combined procedures were demonstrated for the overall, abdominoplasty, and belt lipectomy groups, which is consistent with data published in 2009 using a 4-year prospective clinical database.[11] In fact, the proportion of operative hematomas overall (around 1%) is more consistent with previously published reports on hematoma incidence in the literature, suggesting the possibility that the literature has a tendency to analyze operative over nonoperative hematomas.[25,26] The difference in conclusions between nonstratified and stratified hematoma data suggests that researchers should be more critical of studies that do not divide hematoma incidence into subgroups. These findings further emphasize that hematoma requiring re-operation is an inaccurate indicator of overall hematoma incidence, and it is essential for future studies to document and include minor hematomas treated in the outpatient setting to fully understand hematoma risk in this patient population.

The only statistically significant result in the stratified hematoma analysis was that there was a higher rate of operative hematomas in thighplasty alone compared with thighplasty with concomitant procedures. However, these data were limited by a much lower sample size compared with the other groups, highlighting the need for deeper investigation to arrive at a definitive conclusion. Analysis of the belt lipectomy hematoma rates was also limited by a very low sample size (n = 30 in the concomitant group), and further research would be beneficial, especially given the notion that body region is a risk factor for hematoma occurrence and the acknowledgement of a paucity of data on this topic.[25] Overall, these results underscore the importance of carefully reporting the severity of hematoma in body contouring procedures, and the low overall incidence of hematomas necessitates large sample sizes to achieve adequate statistical power.

Notably, transfusion requirements were documented by 15 studies and demonstrated a significantly higher incidence of intraoperative blood transfusions in concomitant- compared with single-procedure groups. However, there was insufficient data for individual analysis of patients undergoing thighplasty. In contrast, postoperative anemia was documented by only five studies and indicated a significantly higher incidence of anemia in patients undergoing single procedures; however, there was not enough data to analyze the belt lipectomy and thighplasty groups individually. The incidence of anemia reported in this review is further limited by reporting bias, as a large number of patients (n = 112) experiencing postoperative anemia were contributed by a single publication.[27] Overall, the exact relationship between VTE or hematoma incidence and these two indicators of intraoperative blood loss is unclear; furthermore, there is a dearth of plastic surgery literature on this topic. In the neurosurgery literature, there is

minimal evidence to suggest that intraoperative blood loss increases the risk of postoperative hematoma.[28] To investigate this further, it would be critical to design an appropriate cohort study—rather than a systematic review—that specifically focuses on these risk factors, which may represent an important area of future work. Interestingly, the administration of tranexamic acid (TXA) has been shown to reduce hematoma rates without thromboembolic complications in implant-based breast reconstruction, and further research on using TXA for postbariatric body contouring procedures would be worthwhile.[29]

The availability of data in this review and subsequent challenges in analysis must be acknowledged. Notably, a majority of the overall data was composed of abdominoplasty data, which inevitably biases and compromises the generalizability of our conclusions. Indeed, the conclusions drawn from the overall group mirror those in the abdominoplasty group. In comparison, much smaller sample sizes from the belt lipectomy and thighplasty groups limited their influence on the overall data, underscoring the need to report more data from these two procedures to match the numbers in abdominoplasty and maximize statistical power.

Our results on bleeding risk in MWL patients undergoing body contouring procedures were likely confounded by other risk factors that were not reported. Any such risk factors likely influenced these patients' eligibility to undergo multiple concomitant procedures. Patient selection for these elective procedures is another confounding variable. Additionally, the reported VTE incidence was extremely low, likely indicating an underestimation. Both of these findings could be attributed to the inconsistency in data reported by the included studies in our review. As acknowledged in another recently published review, there was no standardized way of defining and reporting complications among these articles, and chemoprophylaxis regimens varied widely across the studies both in pharmacological agent used and duration of treatment, presenting a tremendous challenge for analysis.[30] Lastly, our data is limited by the exclusion of the small sample of patients undergoing brachioplasty and mastopexy, procedures that could also impact the overall incidence of VTE and bleeding events in the MWL population.

CONCLUSIONS

MWL patients undergoing single body contouring procedures (abdominoplasty, belt lipectomy, thighplasty) were found to have a higher risk of hematoma compared with those undergoing combined contouring procedures. However, importantly, stratified hematoma data revealed no differences in overall risk between single- and multiple-procedure operations. The reported VTE incidence was extremely low, partly attributed to the inconsistent documentation protocols across different institutions. For future direction, we propose that standardized reporting of complications, careful documentation of hematoma severity, consistent assessment of VTE risk (ie, Caprini Score), and standardized VTE

chemoprophylaxis protocols for body contouring would aid in more uniform and robust data to be used in clinical practice.

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