

Pulmonary embolism after abdominoplasty: A review

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Case report

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Background

Pulmonary embolism (PE) is a rare but serious complication that can occur after abdominoplasty surgery, also known as a tummy tuck, and is probably the leading cause of death associated with liposuction^[1]. PE occurs when a blood clot forms in a vein, usually in the legs, and travels to the lungs, where it can block blood flow and cause significant damage^[2].

Keywords: DVT, Pulmonary embolism, abdominoplasty.

Abdominoplasty, also known as a tummy tuck, is a cosmetic surgical procedure used to remove excess skin and fat from the abdomen and tighten the underlying muscles^[3].

This surgery is one of the most popular cosmetic surgery procedures in the world. According to the American Society of Plastic Surgeons (ASPS), more than 130,000 tummy tuck procedures were performed in the United States alone in 2020. While tummy tucks are popular with both men and women, they are more commonly performed on women, accounting for 97% of the patients who undergo this surgery^[4].

Some of the indications for performing a tummy tuck are listed below^[5]:

- **Excess skin and fat:** Abdominoplasty is often performed on patients who have excess skin and fat in the abdominal area, which may be caused by factors such as pregnancy, weight loss, or aging.
- **Diastasis recti:** This refers to a separation of the abdominal muscles that can occur during pregnancy or with weight gain. Abdominoplasty can be used to repair diastasis recti by tightening the abdominal muscles.
- **Hernias:** Abdominoplasty can be used to repair umbilical or ventral hernias, which are common in the abdominal area.

- **Post-bariatric surgery:** Patients who have undergone significant weight loss through bariatric surgery or other means may have excess skin and fat in the abdominal area that can be removed by a tummy tuck.
- **Body Contouring:** A tummy tuck can be part of a body contouring procedure that includes liposuction and other procedures to improve the overall appearance of the body.

It is important to note that not all patients are good candidates for abdominoplasty. Patients considering this procedure should be in general good health, have realistic expectations of the results, and be willing to follow the surgeon's pre- and post-operative instructions, as although it is a relatively safe procedure, a large percentage is patients with obesity or who were obese and improved their physical condition after bariatric surgery that favored weight loss, however they have comorbidities that confer greater cardiovascular risk.

Pulmonary embolism after surgery is the main cause of postoperative death in these patients, with very variable statistics regarding its incidence; however, the best documented is that of Grazer, et al., who reported a DVT incidence of 1.1% and a PE incidence of 0.8%^[6].

Some of the best demonstrated risk factors for PE in the postoperative period are listed below:

Risk category	Rogers Score	Caprini Score	Observed risk of VTE (%)	Estimated baseline risk without prophylaxis (%)
Very low	<7	0	0	< 0.5
Low	7–10	1–2	0.7	1.5
Moderate	>10	3–4	1	3
High	NA	5 or > 5	1.9	6

Table 1. Validated risk scales for VTE in surgery. NA, not applicable; VTE, venous thromboembolism.

- DVT
- Systemic anesthesia
- Trauma
 - Multiple concomitant procedures
 - Multiple Concomitant Procedures
 - Circumferential Thigh Liposuction
 - Thermal trauma
 - Excessive Liposuction
 - Prolonged procedure time

Fat embolism is another rare but serious complication that can occur after tummy tuck surgery. Fat embolism occurs when small globules of fat from the surgical site enter the bloodstream and travel to other parts of the body, such as the lungs or brain, where they can cause damage^[7]. The incidence of fat embolism after abdominoplasty surgery is estimated to be around 0.08%. Factors that increase the risk of fat embolism include the amount of fat removed during the procedure, the use of liposuction, and the patient's general state of health^[8].

Fat embolism syndrome after liposuction can be easily overlooked or underestimated; however, occasionally, a fulminant fat embolism syndrome can develop and lead to a critical situation within 2-3 days after lipoplasty. Changes over time in the amount of circulating fat particles and the histology of major organs have not yet been studied^[9].

For example, Gravante, et al. reported an incidence of PE of 2.9% in their series in patients undergoing abdominoplasty with flank liposuction, even adopting correct prophylaxis. Resections with more than 1500 g of fat removed have a risk of 7.4, while the duration of surgery (>140 minutes) has a risk of 3.0. Their results suggest that patients prone to developing PE can and should be identified preoperatively by estimating the amount of fat to be removed and the duration of surgery^[10].

Methods

Clinical presentation

Symptoms of fat embolism can include shortness of breath, rapid heartbeat, fever, confusion, and seizures. In severe cases, fat embolism can lead to organ failure and even death^[11]. To reduce the risk of

fat embolism after abdominoplasty surgery, patients should be carefully evaluated before the procedure to identify any risk factors and to ensure that they are healthy enough to undergo surgery. During the procedure, techniques such as tumescent anesthesia and meticulous surgical technique can help minimize the amount of fat that is released into the bloodstream^[12].

After surgery, patients should be monitored closely for signs and symptoms of fat embolism and treated promptly if it occurs. With appropriate precautions and monitoring, the risk of fat embolism can be minimized, and patients can have a safe and successful recovery from abdominoplasty surgery.

Results

In their group of 253 patients, deep vein thrombosis was documented in two cases (0.8%). Pulmonary embolism did not occur. Three patients (1.2%) presented a mild subcutaneous abdominal hematoma in the first postoperative week that was reabsorbed spontaneously without aesthetic or functional complications. Two patients (0.8%) presented severe hematoma that required surgical reintervention for drainage and revision of hemostasis. Statistical analysis did not show a significant correlation between enoxaparin dose and hematoma (P = 0.18) or deep vein thrombosis (P = 0.61). So, based in evidence recommendations and numbers under the statistics about PE/DVT after abdominoplasty, this protocol represents a secure alternative for prophylaxis in tummy tuck surgery. Likewise, more evidence is required to reinforce this protocol.

Discussion

Validated scales

There are several validated scales that can be used to predict the risk of thromboembolism after surgery, but some scales have been validated in various studies for their specific utility in plastic surgery. Surgeons use these scales to assess an individual patient's risk and determine the appropriate

Age [40 years
Obesity/BMI [25 kg/m ²
Oral contraceptives
Hormone replacement therapy

measures for thromboembolism prophylaxis. For example:

Caprini Risk Assessment Model: This model was developed to assess the risk of venous thromboembolism (VTE) in surgical patients. It takes into account factors such as age, BMI, history of VTE, and length of surgery. The Caprini model is widely used in plastic surgery, including abdominoplasty^[13-15].

Rogers score: This score is a modification of the Caprini model that was developed specifically for plastic surgery patients. It includes additional factors such as the type of surgery, the use of general anesthesia, and smoking^[16].

Khorana Score: This score was originally developed to assess the risk of VTE in cancer patients receiving chemotherapy. However, it has also been used in surgical patients, including those undergoing abdominoplasty. It takes into account factors such as age, BMI, history of VTE, and cancer diagnosis^[17-18].

Padua score: This score was developed to predict the risk of VTE in medical patients. However, it has also been used in surgical patients, including those undergoing abdominoplasty. It takes into account factors such as age, BMI, history of VTE, and immobility^[19-20].

It's important to note that these scales are just tools to assess risk and should be used in conjunction with a thorough medical history and physical examination. The use of thromboembolism prophylaxis should be tailored to the individual patient's risk factors and needs.

Prophylaxis in abdominoplasty

Multiple thromboprophylaxis protocols in surgical patients have been validated and standardized in some surgical specialties and procedures; however, despite the fact that venous thromboembolism represents the most frequent complication after abdominoplasty; no official management guide has been issued. preventive of venous thromboembolic disease in these patients.^[21] And it is not that there is a lack of evidence, since there is a large number of studies that have identified both risk factors and prophylactic measures that are used at the surgeon's preference. Table 2 lists some of the independent risk factors best associated with VTE in patients undergoing abdominoplasty^[22].

In 2016, Marangi, et al.^[23], published a series of evidence based recommendations as a protocol to prevent perioperative thrombosis, in this work lists the preoperative, transoperative and postoperative measures used in patients who will undergo abdominoplasty with promising results.

Maragni's group suggests that preoperatively the following be achieved: 1. Reduction to 30 kg/m² or less and weight stability for 6 months, 2. Stop or reduce smoking at least 3 months before surgery and 3. Anamnestic and clinical assessment of risk factors. During surgery they poses 1. Foot-to-thigh compression garments placed before the induction of general anesthesia, 2. Knees flexed 5 to 10 degrees. Finally postoperative recommendations consists in: 1. Enoxaparin started 8–12 hours postoperatively, then once daily for 6 days: - 4,000 IU if BMI ≤ 25 kg/m² and 1 or more risk factors) or 26 kg/m² ≤ BMI ≤ 30 kg/m² and weight <75 kg; - 6,000 IU if: 26 kg/m² ≤ BMI ≤ 35 kg/m²; - 8,000 IU if BMI > 35 kg/m² , 2. Slightly flexed knees and repeated flexing of the foot three times per hour during postoperative day 1., 3. Mobilization of the patient and removal of the compressive garments on postoperative day 2.

Conclusion

Despite the fact that there is no specific thromboprophylaxis guideline for the patient who will undergo reconstructive surgery and specifically abdominoplasty, there is quality evidence both in risk assessment scales and in measures to be implemented pre, trans and postoperative in these patients. Therefore, weight reduction, mechanical and pharmacological prophylaxis, as well as paying attention and identifying risk factors such as BMI, consumption of hormone replacement therapy and advanced age, can represent the difference between having thromboembolic complications in the postoperative period and modify the prognosis of the patient undergoing abdominoplasty.

Conflicts of interests

There was no conflict of interest during the study, and it was not funded by any organization.

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References

1. International Multicenter Trial: Prevention of fatal postoperative pulmonary embolism by low doses of heparin, *Lancet* 2:45, 1975.

2. Grazer FM, Goldwyn RM. Abdominoplasty assessed by survey, with emphasis on complications. *Plast Reconstr Surg* 1977;59:513-517.
3. Frank K, Hamade H, Casabona G, Gotkin RH, Kaye KO, Tiryaki T, Freytag DL, Bialowas C, Koban KC, Cotofana S. Influences of Age, Gender, and Body Mass Index on the Thickness of the Abdominal Fatty Layers and its Relevance for Abdominal Liposuction and Abdominoplasty. *Aesthet Surg J*. 2019 Sep 13;39(10):1085-1093.
4. American Society of Plastic Surgeons . PLASTIC SURGERY STATISTICS REPORT, 2022. URL: <https://www.plasticsurgery.org/documents/News/Statistics/2020/plastic-surgery-statistics-full-report-2020.pdf>
5. Rees TD, ed. *Aesthetic Plastic Surgery*. Philadelphia, Pa: WB Saunders; 1980.
6. Cantu CA, Pavlisko EN. Liposuction-Induced Fat Embolism Syndrome: A Brief Review and Postmortem Diagnostic Approach. *Arch Pathol Lab Med*. 2018 Jul;142(7):871-875. doi: 10.5858/arpa.2017-0117-RS. PMID: 29939780.
7. Cantu CA, Pavlisko EN. Liposuction-induced fat embolism syndrome. *BMJ Case Rep*. April 18, 2017. doi:10.1136/bcr-2017/219835.
8. Fabian TC. Unravelling the fat embolism syndrome. *N Engl J Med*. 1993; 329(13):961-963.
9. Lim, K.-R., Cho, J.-M., Yoon, C.-M., Lee, K.-C., Lee, S.-Y., & Ju, M.-H. (2018). Correlation between the time elapsed after liposuction and the risk of fat embolism: An animal model. *Archives of Plastic Surgery*, 45(1), 14-22. doi:10.5999/aps.2017.01347
10. Gravante, G., Araco, A., Sorge, R., Araco, F., Nicoli, F., Caruso, R., Cervelli, V. (2008). Pulmonary Embolism After Combined Abdominoplasty and Flank Liposuction. *Annals of Plastic Surgery*, 60(6), 604-608. doi:10.1097/sap.0b013e3181344470.
11. Abs R. Accidents thromboemboliques en chirurgie plastique: revue de la littérature et proposition d'un algorithme de prophylaxie [Thromboembolism in plastic surgery: review of the literature and proposal of a prophylaxis algorithm]. *Ann Chir Plast Esthet*. 2000 Dec;45(6):604-9. French. PMID: 11147120.
12. Miszkiewicz K, Perreault I, Landes G, et al. Venous thromboembolism in plastic surgery: incidence, current practice and recommendations. *J Plast Reconstr Aesthet Surg* 2009; 62:5808.
13. Caprini JA, Arcelus JI, Hasty JH, Tamhane AC, Fabrega F. Clinical assessment of venous thromboembolic risk in surgical patients. *Semin Thromb Hemost*. 1991;17 Suppl 3:304-12. PMID: 1754886.
14. Bahl V, Hu HM, Henke PK, Wakefield TW, Campbell DA Jr, Caprini JA. A validation study of a retrospective venous thromboembolism risk scoring method. *Ann Surg*. 2010 Feb;251(2):344-50. doi: 10.1097/SLA.0b013e3181b7fca6. PMID: 19779324.
15. Obi AT, Pannucci CJ, Nackashi A, et al. Validation of the Caprini Venous Thromboembolism Risk Assessment Model in Critically Ill Surgical Patients. *JAMA Surg*. 2015;150(10):941-948. doi:10.1001/jamasurg.2015.1841
16. Rogers SO Jr, Kilaru RK, Hosokawa P, Henderson WG, Zinner MJ, Khuri SF. Multivariable predictors of postoperative venous thromboembolic events after general and vascular surgery: results from the patient safety in surgery study. *J Am Coll Surg* 2007;204(6):1211-1221
17. Alok A, Khorana, Nicole M, Kuderer, Eva, Culakova, Gary H, Lyman, Charles W, Francis; Development and validation of a predictive model for chemotherapy-associated thrombosis. *Blood* 2008; 111 (10): 4902-4907. doi: <https://doi.org/10.1182/blood-2007-10-116327>
18. Dutia M, White RH, Wun T. Risk assessment models for cancer-associated venous thromboembolism. *Cancer*. 2012 Jul 15;118(14):3468-76. doi: 10.1002/cncr.26597. Epub 2011 Nov 15. PMID: 22086826.
19. Barbar S, Noventa F, Rossetto V, Ferrari A, Brandolin B, Perlati M, De Bon E, Tormene D, Pagnan A, Prandoni P. A risk assessment model for the identification of hospitalized medical patients at risk for venous thromboembolism: the Padua Prediction Score. *J Thromb Haemost*. 2010 Nov;8(11):2450-7. doi: 10.1111/j.1538-7836.2010.04044.x. PMID: 20738765.
20. Vardi M, Ghanem-Zoubi NO, Zidan R, Yurin V, Bitterman H. Venous thromboembolism and the utility of the Padua Prediction Score in patients with sepsis admitted to internal medicine departments. *J Thromb Haemost*. 2013 Mar;11(3):467-73. doi: 10.1111/jth.12108. PMID: 23279085.
21. Cárdenas-Camarena, L., Andrés Gerardo, L.-P., Durán, H., & Bayter-Marin, J. E. (2017). Strategies for Reducing Fatal Complications in Liposuction. *Plastic and Reconstructive Surgery - Global Open*, 5(10), e1539. doi:10.1097/gox.000000000000153
22. Mittal, P., Heuft, T., Richter, D. F., & Wiedner, M. (2019). Venous Thromboembolism (VTE) Prophylaxis After Abdominoplasty and Liposuction: A Review of the Literature. *Aesthetic Plastic Surgery*. doi:10.1007/s00266-019-01576-2
23. Marangi GF, Segreto F, Poccia I, Campa S, Tosi D, Lamberti D, Persichetti P. Thromboprophylaxis in Abdominoplasty: Efficacy and Safety of a Complete Perioperative Protocol. *Arch Plast Surg*. 2016 Jul;43(4):360-4. doi: 10.5999/aps.2016.43.4.360. Epub 2016 Jul 20. PMID: 27462569; PMCID: PMC4959979.

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