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Impact of COVID-19 on Thrombotic Complications in Microsurgery: Deep Inferior Epigastric Perforator Flap Outcomes Amid Pandemic

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Background: Emerging research underscores the heightened risk of vasculitis and microvascular thrombosis in COVID-19 patients, alongside concerns about prothrombotic events post–severe acute respiratory syndrome coronavirus 2 vaccination. Following the pandemic's end, we sought a comprehensive analysis to elucidate its impact on microsurgical thrombosis rates, informed by empirical and anecdotal evidence.

Methods: An institutional review board–approved retrospective review analyzed autologous breast reconstruction cases in women from January 2019 to March 2022. Data on patient history, COVID-19 infection, vaccination status, and postoperative complications were collected. Patients were categorized as prepandemic and pandemic, and based on COVID-19 influence (infection or vaccination) for statistical evaluation.

Results: Among 527 patients, 216 underwent surgery prepandemic and 311 during the pandemic, revealing thrombotic event rates of 3.2% and 5.4%, respectively. Further comparative analysis showed no significant difference in thrombotic events among patients affected by COVID-19 through infection or vaccination during the pandemic.

Conclusions: Contrary to concerns, COVID-19 infection or vaccination status does not significantly increase thrombotic event rates in deep inferior epigastric perforator flap breast reconstructions. This study offers vital insights, affirming the safety and efficacy of microsurgical procedures amid the pandemic, thereby guiding microsurgeons in optimizing patient care in the post–COVID-19 era.
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INTRODUCTION

Microsurgery, known for its high efficacy with success rates of up to 97%, experiences a notable decline in outcomes among patients in hypercoagulable states where the success rate decreases to 85%.[1] Factors contributing to free flap failure include vascular occlusion, extended ischemia duration, and the necessity for pedicle revision.[2,3] In this context, the Caprini score emerges as a pivotal risk assessment tool for venous thromboembolism (VTE). Particularly in deep inferior epigastric perforator (DIEP) flaps, the incidence of VTE escalates from 2% in patients with a Caprini score of less than 4 to 13% in those with scores exceeding 8.[4] However, the Caprini score does not encompass all individual thrombotic risk factors, and the advent of COVID-19 has further complicated the landscape—potentially heightening the risk of thromboembolism.[5]

Emerging evidence indicates that COVID-19 infection precipitates a prothrombotic disorder, leading to an increased occurrence of thromboembolic events.[6,7] Proposed mechanisms include endothelial invasion prompting immunothrombosis, elevation of coagulation factors, and increased secretion of proinflammatory cytokines and chemokines.[8] Research has illuminated a concerning correlation between COVID-19 infection and elevated rates of 30-day mortality, surgical complications, and thrombotic events.[9,10] Specifically for microsurgeons, the risk of vasculitis and microvascular thrombosis

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in patients exhibiting COVID-19 complications has been substantiated through multiple studies.[11–13]

In addition to concerns regarding surgical outcomes, the pandemic significantly impacted surgical training for plastic surgery residents, both in the states and abroad.[14,15] With reduced operative volumes, many residents were redeployed to cover COVID-19 teams, working in intensive care units (ICUs) and emergency departments.[16] This reallocation of resources, combined with restricted access to traditional training environments, created unique challenges for residency programs in maintaining plastic surgery education while grappling with the evolving demands of patient care during COVID-19. Despite the development of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) vaccine marking a significant milestone in pandemic management, apprehensions regarding prothrombotic events postvaccination persist.

Although some investigations and case reports advocate for a heightened incidence of hypercoagulable events postvaccination, research by Taghioff et al[17] presents a nuanced view. Their findings suggest a reduction in the risks of flap failure, surgical site infections, ICU admissions, generalized infections, and hospital stays following microsurgical procedures in vaccinated individuals. Nevertheless, the protective efficacy of the vaccine against thrombotic events such as pulmonary embolism (PE) and deep vein thrombosis (DVT) remains unproven, particularly when comparing vaccinated individuals against those not vaccinated for SARS-CoV-2.[17]

Prompted by the World Health Organization's declaration marking the conclusion of the COVID-19 pandemic, our research endeavors to scrutinize the genuine impact of this viral infection on microsurgery. Preliminary observations and scientific inquiry hint at an augmented thrombosis rate. Using a comprehensive database of DIEP flap procedures conducted at our institution, we undertook an analysis encompassing more than 500 patients, pre- and postpandemic. This investigation aims to elucidate the actual incidence of flap complications or VTE linked to both natural infection and vaccine administration, thereby contributing to the evolving narrative of COVID-19's implications in the realm of microsurgery.

Takeaways

Question: How did the COVID-19 pandemic affect thrombotic complications in deep inferior epigastric perforator (DIEP) flap microsurgical breast reconstructions?

Findings: This retrospective study reviewed 527 DIEP flap cases from January 2019 to March 2022, comparing thrombotic event rates pre- and postpandemic. Thrombotic events were higher during the pandemic (5.4%) compared with prepandemic (3.2%). Importantly, there was no significant difference in thrombotic events between patients with COVID-19 infection and those who were vaccinated.

Meaning: COVID-19 infection or vaccination does not seem to significantly increase thrombotic risks in DIEP flap breast reconstructions, supporting the safety of these procedures both during and after the pandemic.

METHODS

Data Collection

An institutional review board–approved retrospective review was conducted for all patients who underwent autologous breast reconstruction with DIEP flap procedures from January 2019 to March 2022 (IRB00076277). This existing database was later amended to include documentation of COVID-19 status for all patients. The onset of the COVID-19 pandemic was marked by the World Health Organization's declaration on March 11, 2020. Hence, patients were stratified into 3 cohorts based on the temporal proximity to this declaration: (1) individuals undergoing DIEP flap breast reconstruction before March 12, 2020; (2) patients receiving surgery after March 12, 2020, without a history of COVID-19 infection or vaccination; and (3) patients receiving surgery after March 12, 2020, with documented COVID-19 infection or vaccination history. The primary complications of interest in this study were flap compromise and VTE.

Key variables for this investigation included patient demographics, comprehensive medical history, detailed postoperative outcomes, COVID-19 vaccination status, and infection history. Flap compromise encompassed total flap loss, partial flap loss, arterial thrombosis, and venous congestion. VTE was characterized by the occurrence of DVT and PE. A thorough statistical examination was conducted to ascertain the incidence of these complications across the defined cohorts.

Statistical Analysis

Statistical analysis was conducted with a significant threshold set at an alpha of less than 0.05. To reduce potential biases from variable weighting, the final analysis included only patients with complete medical records. The patient groups were categorized into 3 cohorts for comparison: pre-March 2020; post-March 2020, without COVID-19 infection or vaccination; and post-March 2020 with COVID-19 infection or vaccination. The Fisher exact test was used to compare count data, particularly due to the low incidence of venous thromboembolic complications. Logistic regression modeling was used to identify predictors of thrombotic events across the 3 cohorts.

RESULTS

Our study encompassed 527 women undergoing DIEP flap breast reconstructions, categorized based on the timing of their surgery relative to the World Health Organization's declaration of the COVID-19 pandemic (Fig. 1). Specifically, patients were divided into 3 distinct groups: those operated on before the declaration (n = 215); those operated on afterward, without a history of COVID-19 infection or vaccination (n = 204); and those with a post-declaration history of infection or vaccination (n = 108).

Patient Demographics and Clinical Characteristics

A thorough comparison of patient demographics and clinical characteristics was conducted, encompassing age,

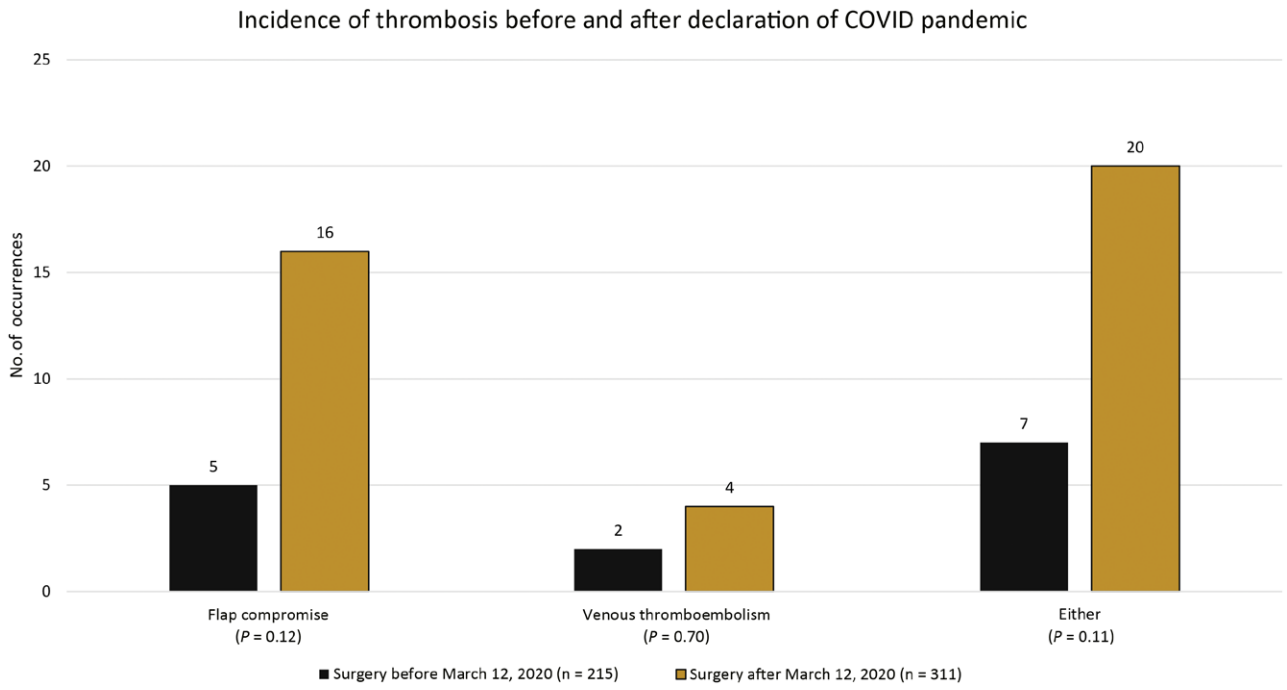

Fig. 1. Thrombotic events before and after declaration of the COVID-19 pandemic.

American Society of Anesthesiologists (ASA) classification, body mass index, tobacco usage, and diabetes status. The analysis reports a statistically significant difference ($P = 0.044$) in diabetes status among the 3 cohorts (Table 1).

Timing of Infection or Vaccination to Surgery

Among the 108 patients who were COVID-19-positive or vaccinated, the median time to DIEP flap surgery was 5.8 months. For the 9 patients who experienced flap failure or VTE, the median time to surgery was 6.4 months versus 5.8 months for the remaining 99 patients without microvascular complications ($P = 0.47$). Furthermore, of those who experienced a thrombotic complication, the shortest time from infection or vaccination to surgery was 1 month, and the longest time was 11.8 months.

Operative Characteristics

Operative details were examined and compared, including exposure to pre- and post-reconstruction radiation therapy, chemotherapy, and the administration of DVT prophylaxis. These operative characteristics did not differ significantly across the 3 patient groups, aside from intraoperative DVT prophylaxis ($P < 0.001$) and postoperative DVT prophylaxis ($P = 0.006$) (Table 2).

Incidence of Complications

Complication rates were examined with a focus on flap compromise, defined as venous congestion, arterial thrombosis, flap failure, or partial flap loss, and VTE—comprising DVT and PE. Before the pandemic, the incidence of flap compromise was 2.3% and VTE was 0.9% (Table 3). In the postpandemic cohorts, the non-COVID-19/nonvaccinated group exhibited flap compromise and VTE rates of 3.9% and 1.5%, respectively. The COVID-19-positive/vaccinated group had a higher flap compromise incidence at 7.4%, with VTE remaining at 0.9%. Notably, among the prepandemic group, multiple complications within our defined category of flap compromise occurred, including 1 patient with 3 such events. Despite these observations, statistical analysis did not yield significant differences in complication rates among the cohorts (flap compromise, $P = 0.090$; VTE, $P = 0.873$) (Table 4).

Logistic Regression Modeling

Univariate regression modeling revealed that intraoperative DVT prophylaxis had a higher odds ratio (5.1) compared with postoperative DVT prophylaxis when evaluating thrombotic outcomes across all 3 cohorts. Despite this, neither were significant predictors with P values of 0.253 and 0.690, respectively. Final logistic regression modeling accounting for age, body mass index, tobacco use, diabetes, and intraoperative DVT prophylaxis demonstrated no consistent strong predictors of thrombosis.

DISCUSSION

Our study contributes to the continuum of research on the implications of COVID-19 for surgical patients, particularly those undergoing microsurgical breast reconstruction with a DIEP. Our analysis revealed a nuanced increase in thrombotic complications postpandemic, despite the relatively small sample size and complication rates of less than 10% across all cohorts. This finding is juxtaposed against historical data, which reports comparable or even lower rates of VTE in similar patient cohorts.[18–24]

Although the data in our study indicate an observed increase in flap compromise in the postpandemic cohort with a history of COVID-19 or vaccination, the differences did not achieve statistical significance. This trend suggests

Table 1. Demographics of Patient Cohorts, Stratified by Timing and COVID-19 Status

Characteristic	Before March 2020 (n = 215)	After March 2020, Without COVID-19 Infection or Vaccination Before Surgery (n = 204)	After March 2020, With COVID-19 Infection or Vaccination Before Surgery (n = 108)	*P*
Age, mean ± SD, y	50.5 ± 10.5	51.2 ± 10.0	50.5 ± 9.8	0.816
BMI, mean ± SD, kg/m²	30.3 ± 5.5	30.3 ± 5.5	29.8 ± 5.1	0.745
ASA score, n (%)				0.743
ASA I	2 (0.9)	1 (0.5)	2 (1.9)	
ASA II	122 (56.7)	113 (55.4)	56 (51.9)	
ASA III	91 (43.3)	90 (44.1)	50 (46.3)	
Race or ethnicity, n (%)				0.291
American Indian/Alaskan Native	0 (0)	4 (2.0)	0 (0)	
Asian	2 (0.9)	3 (1.5)	1 (0.9)	
Black/African American	51 (23.7)	44 (21.6)	25 (23.1)	
Native Hawaiian/Pacific Islander	0 (0)	0 (0)	1 (0.9)	
White	156 (72.6)	150 (73.5)	80 (74.1)	
Multiracial	1 (0.5)	2 (1.0)	0 (0)	
Unknown	4 (1.9)	0 (0)	1 (0.9)	
Hispanic/Latino	1 (0.5)	1 (0.5)	0 (0)	
Tobacco use, n (%)				0.760
Never	142 (66.0)	144 (70.6)	69 (63.9)	
Former, >1 y	56 (26.0)	45 (22.1)	32 (29.6)	
Former, <1 y	13 (6.0)	10 (4.9)	6 (5.6)	
Current	4 (1.9)	5 (2.5)	1 (0.9)	
Diabetes, n (%)				**0.044***
None	196 (91.2)	179 (87.7)	94 (91.2)	
Prediabetes	6 (2.8)	3 (1.5)	6 (2.8)	
Type I DM	0 (0)	1 (0.5)	0 (0)	
Type II DM	13 (6.0)	21 (10.3)	13 (6.0)	
Hypertension, n (%)				0.489
Yes	54 (25.1)	25 (23.1)	59 (28.9)	
No	161 (74.9)	83 (76.9)	145 (71.1)	

Bold and * values indicate statistical significance.
BMI, body mass index; DM, diabetes mellitus.

Table 2. Operative Characteristics Patient Cohorts, Stratified by Timing and COVID-19 Status

Characteristic	Before March 2020 (n = 215)	After March 2020, Without COVID-19 Infection or Vaccination Before Surgery (n = 204)	After March 2020, With COVID-19 Infection or Vaccination Before Surgery (n = 108)	*P*
History of breast cancer, %				0.994
Yes	89.3	89.2	88.9	
No	10.7	10.8	11.1	
Prereconstruction radiation therapy, %				0.649
Yes	47.4	52.0	49.1	
No	52.6	48.0	50.9	
Prereconstruction chemotherapy, %				0.570
Yes	47.4	42.6	47.2	
No	52.6	57.4	52.8	
Preoperative DVT prophylaxis, %				0.164
Yes	97.2	95.1	92.6	
No	2.8	4.9	7.4	
Intraoperative DVT prophylaxis, %				**<0.001***
Yes	8.8	14.7	34.3	
No	91.2	85.3	65.7	
Postoperative DVT prophylaxis, %				**0.005**
Yes	88.4	96.6	93.5	
No	11.6	34.4	6.5	
Postoperative aspirin, %				0.295
Yes	60.0	64.7	68.5	
No	40.0	35.3	31.5	
Median total operative time, min	419	349	385	**0.001**
Median length of stay, d	3	2	2	**<0.001***

Bold and * values indicate statistical significance.

Table 3. Incidence of Thrombosis Stratified by Date of Surgery and COVID-19 Status

	Before March 2020 (n = 215)	After March 2020, Without COVID-19 Vaccine or Infection Before Surgery (n = 204)	After March 2020, With COVID-19 Vaccine or Infection Before Surgery (n = 108)	*P*
Combined complication, n (%)	7 (3.2)	11 (5.4)	9 (8.3)	0.1277
Flap compromise, n (%)	5 (2.3)	8 (3.9)	8 (7.4)	0.0902
Venous thromboembolism, n (%)	2 (0.9)	3 (1.5)	1 (0.9)	0.8732

Table 4. Postoperative Complications of Patients by COVID-19 Timing and Status

	Before March 2020 (n = 215)	After March 2020, Without COVID-19 Vaccine or Infection Before Surgery (n = 204)	After March 2020, With COVID-19 Vaccine or Infection Before Surgery (n = 108)	*P*
Complication: partial flap loss, n (%)				0.1896
No	216 (100)	201 (99.0)	108 (100)	
Yes	0 (0.0)	2 (1.0)	0 (0.0)	
Complication: flap failure, n (%)				0.4415
No	214 (99.1)	202 (99.5)	106 (98.2)	
Yes	2 (0.9)	1 (0.5)	2 (1.8)	
Complication: arterial thrombosis, n (%)				0.1896
No	216 (100)	201 (99.0)	108 (100)	
Yes	0 (0.0)	2 (1.0)	0 (0.0)	
Complication: venous congestion, n (%)				0.0886
No	212 (98.1)	197 (97.0)	101 (93.5)	
Yes	4 (1.9)	6 (3.0)	7 (6.5)	
Flap compromise, n (%)				0.0902
No	211 (97.7)	195 (96.1)	100 (92.6)	
Yes	5 (2.3)	8 (3.9)	8 (7.4)	
Pulmonary embolism, n (%)				0.5374
No	214 (99.1)	200 (98.5)	108 (100)	
Yes	2 (0.9)	3 (1.5)	0 (0.0)	
DVT, n (%)				0.2049
No	216 (100)	203 (100)	107 (99.1)	
Yes	0 (0.0)	0 (0.0)	1 (0.9)	
Venous thromboembolism, n (%)				0.8732
No	214 (99.1)	200 (98.5)	107 (99.1)	
Yes	2 (0.9)	3 (1.5)	1 (0.9)	
Thrombotic events, n (%)				0.1277
No	211 (96.8)	195 (94.6)	100 (91.7)	
Yes	7 (3.2)	11 (5.4)	9 (8.3)	

a potential clinical impact of the pandemic on thromboembolic event risk, warranting further investigation with larger sample sizes to enhance statistical power. The findings, therefore, must be contextualized within the limitations of the data, refraining from definitive conclusions regarding the influence of COVID-19 on thrombotic risks in DIEP flap reconstruction.

Thrombotic Complications in COVID-19

The intersection of COVID-19 and thrombotic complications presents a significant area of concern in the realm of microsurgical procedures, drawing attention to the underlying pathophysiological mechanisms and clinical implications. Klok et al[25,26] reported a striking 31% incidence of thrombotic complications in ICU patients with COVID-19, emphasizing the critical importance of pharmacological thrombosis prophylaxis in this patient population. The study's findings strongly suggest considering increased prophylaxis doses, despite the lack of randomized evidence to support such an approach.[25,26]

The pathophysiological underpinnings of thrombosis in the context of COVID-19 are complex and stem from a variety of proposed mechanisms. First, the infection has the potential to compromise endothelial function, attributed to the virus's ability to invade endothelial cells, causing endothelial inflammation, complement activation, and thrombin generation, which culminate in immunothrombosis.[27] Furthermore, COVID-19 may induce a hypercoagulable condition marked by elevated concentrations of coagulation factors and a reduction in anticoagulant substances. Additionally, the systemic inflammatory response triggered by the infection contributes to the risk of thrombosis by fostering the secretion of proinflammatory cytokines and chemokines. This multifaceted interaction among endothelial dysfunction, hypercoagulability, and inflammation elucidates the intricate nexus at which COVID-19 intersects with thrombotic risk.

As the pandemic evolved, different strains of the SARS-CoV-2 virus emerged secondary to genetic mutation and resultant viral antigenic drift, with some variants associated

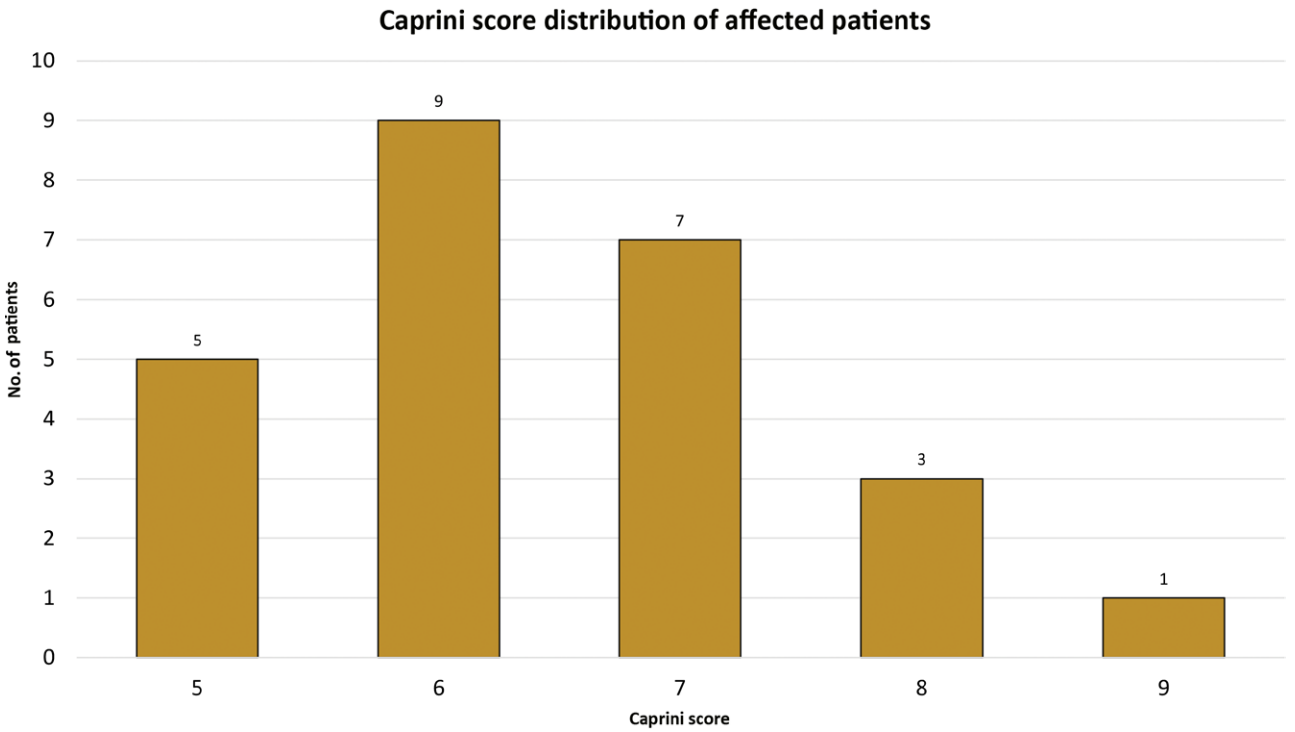

Fig. 2. Histogram illustrating the distribution of Caprini scores in 25 of the 27 total patients who experienced VTE postsurgery.

with more severe disease than others. The first of the widely recognized variants of concern, alpha and beta, emerged in 2020 in the United Kingdom and South Africa, respectively, and were thought to be more contagious than the original strain.[28] The arrival of the delta variant in 2021 produced a rapid surge in cases worldwide due to increased transmissibility and yielded more severe symptoms in the unvaccinated.[29] Omicron and its multiple subvariants surfaced in 2022 and continue as the prevailing strains in the United States today with mutations aiding viral entry into host cells and resultant transmissibility.[30] This heterogeneity of SARS-CoV-2 variants over time and patient vaccination status may have influenced the outcomes in our study, and future research should account for the strain and severity of infection when analyzing the impact on surgical outcomes.

Patients included in this study were unlikely to have had active, symptomatic COVID-19 at the time of surgery, as elective procedures were deferred in such cases. Therefore, the heightened thrombotic risk associated with active infection may not have been fully captured. Furthermore, patients were identified by the presence or absence of infection and vaccination status, but specific variants of SARS-CoV-2 were not reported. This highlights a key limitation of the study design. In our cohort, the median time from infection or vaccination to surgery was 5.8 months. Although this timeframe likely reflects resolved infection, it remains uncertain whether prolonged intervals may influence thrombotic risks. This aspect requires further investigation in larger, prospective studies.

Limitations of the Caprini Score

The Caprini score, widely utilized for VTE risk stratification in surgical patients, may not fully account for the unique risk factors presented by COVID-19, indicating a need for updated guidelines that incorporate the latest evidence on COVID-19-associated thrombotic risks.

Given the challenging nature of ascertaining accurate Caprini scores with limited data during retrospective chart review, we elected to calculate best the Caprini scores of the affected patients (25 of 27) to see if the data followed a normal distribution and could be extrapolated to draw the broader conclusion that the score could otherwise be interpreted as insignificant in the setting of a thrombotic event. The mean Caprini score among affected patients experiencing VTE postsurgery was 6.44, closely aligning with the mode and median, which are both 6 (Fig. 2). This suggests a consistent risk profile in the majority of affected patients and may indicate that a Caprini score of 6 is particularly prevalent when considering operative and demographic statistics for patients undergoing oncological breast reconstruction.

Study Limitations and Considerations

Our analysis has unveiled an ostensibly increased incidence of postoperative complications, particularly flap compromise and VTE, in the cohort of patients undergoing DIEP flap breast reconstruction postpandemic who had a history of COVID-19 infection or vaccination (Fig. 3). Although these findings, at first glance, suggest a potential exacerbation of thrombotic risks associated with the pandemic, it is imperative to contextualize these observations within the constraints of our study's sample size and statistical power.

Our existing DIEP database was intended to document all procedures at our institution to analyze outcomes and complications, and COVID-19 status was retrospectively

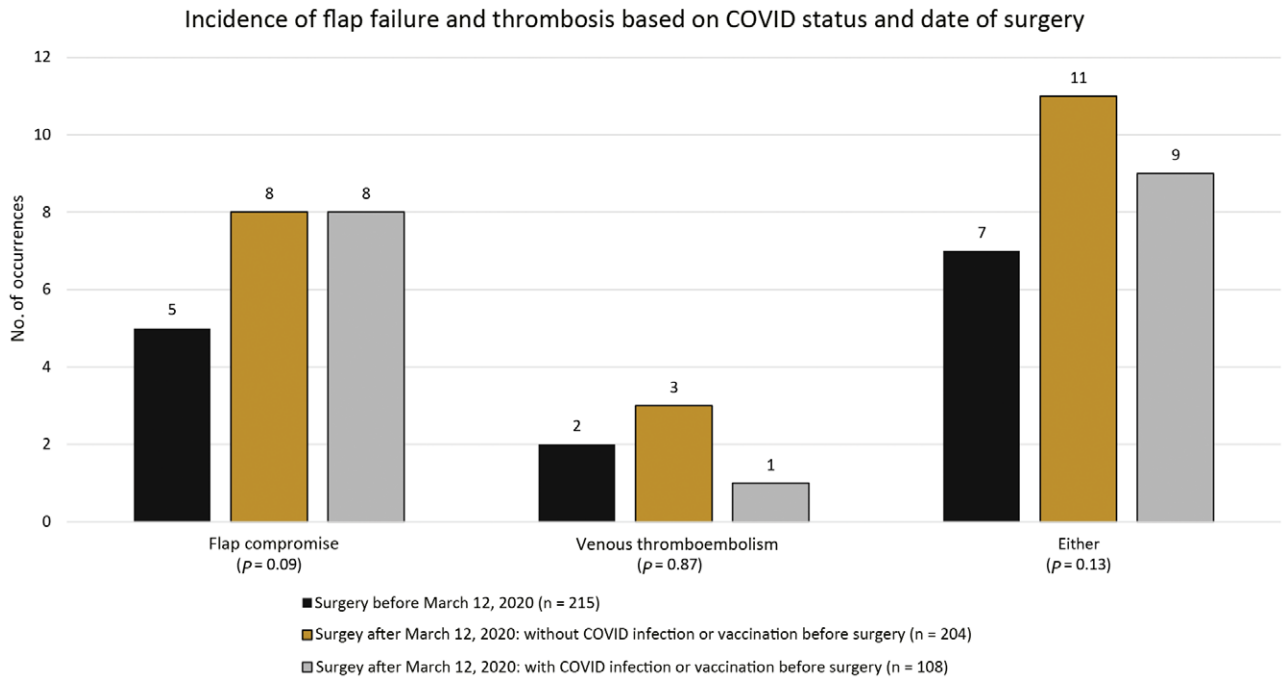

Fig. 3. Incidence of flap failure and thrombosis based on COVID-19 status and date of surgery.

added at a later date. We acknowledge that the investigators were not blinded to infection or vaccination status, which introduces the potential for allocation bias. Although this was a limitation of our retrospective study, future research should aim to include blinded outcome assessors to minimize bias.

A preliminary sample size calculation was not performed, as we included all patients to date and would be unable to conduct additional procedures. However, the study reports 98.1% and 99.3% power for the combined complication rate and flap compromise rate, respectively. For VTE, the study sample size did not reach sufficient power to detect small differences in complication rates.

Postinfection and postvaccination patients were combined into a single cohort due to the small sample size of patients with confirmed infection. This allowed for a more robust statistical comparison, though we recognize the heterogeneity of these groups. Future studies should consider separating vaccinated individuals with and without prior infection.

One of the pivotal limitations of our study lies in the relatively small number of observed complications, which inherently challenges the detection of statistically significant differences among the cohorts. As elucidated in our analysis, the difference in complication rates—3.2% prepandemic versus 8.3% in the COVID-positive/vaccinated group postpandemic—did not reach statistical significance, as indicated by a Fisher exact test *P* value of 0.128. This lack of significance underscores the critical role that sample size plays in the statistical analysis of rare events. The phenomenon where smaller sample sizes diminish the study's power to detect true differences is well documented in epidemiological research, necessitating cautious interpretation of our findings.

Furthermore, the ethical dimension of statistical reporting mandates a comprehensive and transparent presentation of all comparison groups. Selectively reporting or excluding specific cohorts to achieve significance not only compromises the integrity of the research but also misleads the scientific community and the public. In our study, we adhered to rigorous ethical standards by presenting all relevant groups, even when this inclusivity meant confronting nonsignificant results.

Preferences among surgeons regarding the choice of anticoagulation, which include options such as subcutaneous heparin, enoxaparin, and other agents, exhibited considerable variability. This study encompassed a patient cohort under the care of a group of surgeons across a span of 3 years, during which a consensus on the anticoagulation regimen was notably absent. There is a compelling need for future prospective research to explore the effects of prolonged anticoagulation, potentially extending for an additional 2–4 weeks in patients identified as high-risk, as suggested by Wu et al.[5] Such studies are crucial for developing standardized protocols that more definitively link the choice, timing, and dosage of anticoagulants with the incidence of VTE.

The methodologies of recent studies primarily involve retrospective analyses and observational cohort studies, which, although informative, are subject to limitations inherent to such study designs. The reliance on hospital records and the potential for selection bias in ICU populations highlight the need for broader, prospective studies

to fully understand the scope of thrombotic risks across all COVID-19 patients, including those undergoing microsurgical procedures.

Future Directions

Despite the growing body of literature on the subject, significant gaps remain in our understanding of the optimal management of thrombotic risks in COVID-19 patients undergoing microsurgical interventions. Future research should aim to (1) determine the long-term thrombotic risks associated with COVID-19 in the microsurgical patient population, (2) evaluate the efficacy of different antithrombotic regimens in reducing postoperative complications, and (3) explore the role of novel biomarkers in predicting thrombotic complications in this unique patient cohort.

Given these considerations, future research endeavors should aim to incorporate larger sample sizes. Enhancing the sample size would augment the study's power, potentially clarifying the true impact of COVID-19 on surgical outcomes. Moreover, longitudinal studies could offer insights into the long-term effects of COVID-19 and vaccination on postoperative complication rates, contributing valuable data to the ongoing discourse on thromboembolic event risk profiles in a postpandemic era.

CONCLUSIONS

Although our study presents a modest examination of the influence of COVID-19 on thrombotic complications in DIEP flap breast reconstructions, the constraints of our sample size highlight the necessity for cautious interpretation. The observed trends, though not statistically significant, invite further investigation with larger cohorts to elucidate the pandemic's real impact on surgical practices and patient outcomes. Through continued research and collaboration, the surgical and scientific communities can better understand and mitigate the risks associated with COVID-19 in the perioperative setting.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

PATIENT CONSENT

Consent for publication was obtained for every person's data included in the study.

ETHICAL APPROVAL

This study has obtained institutional review board approval (IRB00076277).

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