doi: 10.48095/ccachp2025160

Brachioplasty after massive weight loss: analyzing wound healing and risk factors for dehiscence

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Summary

Background: Brachioplasty in the post-bariatric patient deserves special attention since a not negligible number of wound complications is reported in the literature. In this study, the authors present unique risk factors for wound dehiscence and delayed wound healing based on retrospective data in post-bariatric patients who underwent brachioplasty alone or with other procedures. **Methods:** A total 31 patients who underwent brachioplasty alone or combined with other procedures between 2017–2022 were included. Data analyzed encompassed demographic information, biometric data, type of brachioplasty if performed alone or in combination with other procedures, days to epithelization/closure, and its management. **Results:** A total of 15 patients (48.38%) experienced surgical wound dehiscence, the majority (66%) being minor wound dehiscence. Subjects who underwent concomitant arm liposuction with brachioplasty showed a higher degree of dehiscence (P = 0.021) and more days to epithelialization/closure (P = 0.10). Fifty-seven percent of patients who underwent a combined procedure showed some degree of dehiscence, as well as more days to epithelialization/closure (41 vs 15.75 days). Brachioplasty and mastopexy as combined procedures demonstrated more days to epithelialization/closure (P = 0.05). **Conclusions:** Brachioplasty in the post-bariatric population is deemed safe and effective; nevertheless, it carries an increased risk of wound dehiscence and delayed wound healing when combined with liposuction and other procedures. The plastic surgeon needs to become familiar with variables that increase the risk of this complication, all of which can be anticipated in preoperative planning.

Key words
brachioplasty – delayed wound healing (DWH) – massive weight loss (MWL) – post-bariatric reconstruction – wound dehiscence

Rojas Gutiérrez CD, Carvallo Maiocco P, Zúñiga Garza E et al. Brachioplasty after massive weight loss: analyzing wound healing and risk factors for dehiscence. Acta Chir Plast 2025; 67(3): 160–166.

Background

Post-bariatric body reconstruction has recently become an area of interest for practicing plastic surgeons, with exponential growth in recent years. With the emergence of novel and safer techniques in bariatric surgery, many patients are seeking a diverse array of reconstructive procedures to address the sequelae of massive weight loss [1]. In 2021, around 140,158 brachioplasties were performed globally, accounting for 1.1% of total aesthetic surgical procedures, according to the International Society of Plastic Surgeons annual report [2].

In our country, around 8,698 upper arm lift procedures were performed in 2022. However, no data indicate which patients underwent these procedures due to bariatric surgery [2]. Although most of these procedures share the same technical principles for aesthetic purposes in healthy patients, the post-bariatric population requires special attention regarding procedure choice, preoperative evaluation, and postoperative management [3]. The literature describes a significant number of wound complications and revision rates with this type of procedure, and there may be underreporting of complications, particularly in the post-bariatric population,

Tab. 1. The Sandy Grading System for surgical wound dehiscence [12].

Grade	Descriptor
I	Minor separation of opposed incisional margins at any point along the incision, < 2 cm depth. No visible subcutaneous layer. No clinical signs and symptoms of or microbiological confirmation of infection.*
Ia	As above with clinical signs and symptoms and/or confirmed microbiological confirmation of infection.*
II	Medium (single or multiple) separations of opposed incisional margins to expose subcutaneous layer, > 5 cm depth. Bridging or tunnelling of dehiscence evident.*
IIa	As above with clinical signs and symptoms and/or confirmed microbiological confirmation of infection.*
III	Major (single of multiple) separation of the incisional margins to expose subcutaneous, fascial/muscle/tendons and or organs.*
IIIa	As above with clinical signs and symptoms and/or confirmed microbiological confirmation of infection.*

*Up to and including day 30 postoperative period

including wound dehiscence and delayed wound healing [4–7].

While some risk factors for complications have been thoroughly described, conditions common in this population, the use of complementary techniques like liposuction, and whether the procedure is performed alone or in combination with others remain current controversies in the literature [6,8–11]. This study aims to evaluate if factors such as liposuction, preoperative conditions frequently found in this population, and concomitant body contouring procedures increase wound dehiscence rates and time to epithelialization/closure in post-bariatric patients who underwent brachioplasty alone or with combination procedures. In this study, the authors use a universal measurement scale [12] to report the degree of dehiscence and propose a clear definition for complete wound healing.

Methods

Data were obtained from physical and electronic records of all patients who underwent brachioplasty alone or in combination with other body contouring procedures at an academic referral center for post-bariatric reconstruction between 2017 and 2022. All procedures were performed by one of four board-certified plastic surgeons with over 10 years of practice experience (including both senior authors), assisted by at least one plastic surgery resident. Before the procedure, all patients were evaluated by a nutritionist, psychiatrist, endocrinologist, and internal medicine specialist to optimize preoperative conditions. Additionally, all patients maintained a stable weight for at least 6 months before surgery. None of the patients were active smokers at the time of the study (at least 6 weeks), as validated by a preoperative survey. Cotinine testing is not routinely performed at our institution.

Patient demographic information included age, gender, body weight before the bariatric procedure, type of bariatric procedure, pre-procedure body weight, body mass index (BMI), Arm Pittsburgh Rating Scale (aPRS), and past medical history, follow-up, including risk factors such as smoking, hypertension, diabetes, and thyroid disease. Preoperative laboratory results were also included. Regarding the procedure, we collected data on the type of brachioplasty (minimal incision, standard, extended, and thoracobrachioplasty), whether it was performed in combination with another post-bariatric reconstructive procedure, and whether liposuction was performed.

At our center, depending on the amount of skin resection, the brachioplasty technique might vary. However, certain steps are followed in a standard manner. During marking, all surgeons use the bicipital groove as a reference and estimate the required skin resection using a pinch maneuver, with an extension toward the elbow or thoracic wall depending on the need for skin excision. This estimate may vary during the procedure, as resection is limited to what is necessary to achieve a tension-free closure.

In all cases, tumescent infiltration is performed over the previously marked resection area using a lidocaine solution with epinephrine at a 1 : 100,000 concentration. Resection is confined to the skin and subcutaneous tissue, preserving as many vascular, lymphatic, and nerve structures as possible. When concomitant liposuction is employed, aspiration is performed until a flap with a pinch thickness of less than 1 cm is obtained, this is done only in the area to be resected.

Postoperative data analyzed included wound dehiscence based on the Sandy Wound Dehiscence Classification (SGSSWD) (Tab. 1) [12], days to closure/epithelialization of wound dehiscence, the need for surgical reintervention, and types of non-operative management. Days to closure/epithelialization were defined as the days between the appearance of wound dehiscence and complete evidence of a stable wound without subcutaneous tissue ex-

posure. This clear and comprehensive definition can be included in future systematic reviews and meta-analyses.

Collected data were recorded in Microsoft Excel (Microsoft®), and SPSS Statistics 29 (IBM Inc.) was used for statistical purposes and data analysis. Individual variables were described separately, including demographic and outcome-related variables for the primary and secondary outcomes: wound dehiscence and days to epithelialization/closure. Numeric variables were analyzed using descriptive statistics, while nominal variables were analyzed using frequency measures and percentages.

Cross-analysis was performed to compare the occurrence and non-occurrence of surgical wound dehiscence among the different variables studied. This was done using the non-parametric Wilcoxon test for numeric variables and Fisher's exact test for nominal variables, considering a statistically significant result with a P-value < 0.05. P-values < 0.1 were considered to identify weaker relationships, even if not statistically significant. The relationship between days to epithelialization/closure and variables analyzed was determined using the Pearson correlation test for numeric variables and the Wilcoxon test for comparing days to epithelialization/closure with nominal risk variables. Odds ratios with their respective confidence intervals were calculated for variables that showed statistical significance in the tests.

Results

The study included 31 patients, with a female predominance with a mean age of 48 ± 8.76 years. The average BMI before surgery was 28 ± 3.31 kg/m^2, while the initial BMI before bariatric surgery averaged 47 ± 7.44 kg/m^2. Gastric bypass was the most common bariatric procedure, performed in 59.3% (N = 19) of patients, followed by gastric sleeve in 35.48% (N = 11), and laparoscopic gastric banding in one case (N = 1) (Tab. 2).

Tab. 2. Patient demographics and preoperative data.

Variable	No.	%	Mean	SD
age (years)	–	–	48.71	± 8.76
sex	female = 30 male = 1	96.77 3.22	–	–
initial BMI (kg/m^2)	–	–	47.23	± 7.44
BMI before procedure (kg/m^2)	–	–	28.54	± 3.31
smokers*	yes = 3 no = 28	9.67	–	–
hypertension	yes = 7 no = 24	22.58 77.41	–	–
diabetes mellitus	yes = 4 no = 27	10.8 87.09	–	–
thyroid disease	yes = 7 no = 24	22.58 77.41	–	–
leukocyte count (103/µL)	–	–	7.18	± 2.54
hemoglobin (g/dL)	–	–	13.12	± 1.32
albumin (g/dL)	–	–	4.31	± 0.38
Arm Pittsburg Rating Scale				
1	0	–	–	–
2	14	45.16	–	–
3	17	54.83	–	–
bariatric procedure				
gastric bypass	19	59.3	–	–
gastric sleeve	11	35.48	–	–
laparoscopic gastric banding	1	6.45	–	–

* All patients had ceased smoking by the time of the study.

The average aPRS score was 3, indicating significant tissue laxity and adiposity in 54.83% (N = 17) of patients. Conventional brachioplasty was the most frequently performed procedure (74.19%), followed by extended brachioplasty, thoracobrachioplasty, and minimal incision brachioplasty. Seven patients underwent combination procedures, with mastopexy the most common (Tab. 3). Liposuction was performed in 22.58% of cases (Tab. 4), with the decision guided by individual assessments of adiposity and potential postoperative contour deformities.

Surgical wound dehiscence occurred in 15 patients (48.38%), with grade I being the most common (N = 9), followed by grade II (N = 5) and grade IIIa in one case. Two patients required surgical intervention: one with grade II dehiscence underwent third-intention closure after 10 weeks of failed conservative treatment for a wound smaller than 1 cm, and the other received two applications of negative pressure wound therapy before undergoing third-intention closure.

The average time to wound closure/epithelialization for patients who did not require surgery was 34 ± 21.28 days (Tab. 5). Calcium alginate was the preferred initial dressing in 60% of cases, followed by pirfenidone in 20%. Hydrogel, silver polyurethane patches, and sulfathiazole were used in the re-

Tab. 3. Type of brachioplasty, brachioplasty in combination with other procedures, occurrence of wound dehiscence and days to epithelization/closure.

Type of brachioplasty (N = 31)			Patients who experienced wound dehiscence (N = 15)		Days to epithelization/ closure
	No.	%	No	%	Mean
conventional	23	74.19	9	39.1	20.35
extended	4	12.90	4	100	41.75
thoracobrachioplasty	3	9.6	1	33.3	10
minimal incision	1	3.22	0	0	0
brachioplasty in combination with other procedures	7	22.58	4	57.1	41
mastopexy	4	57.14	3	75	53.75
cruroplasty	1	3.22	0	0	0
torsoplasty	1	3.22	1	100	72
others*	1	3.22	0	0	0

*Mastectomy was performed in the male patient to correct gynecomastia.

Tab. 4. Use of liposuction as an adjunct to brachioplasty.

	Global (N = 31)		Dehiscence (N = 15)		Days to epithelization/ /closure time*
	No.	%	No.	%	Mean
with liposuction	7	22.58	6	85.7	28.6
without liposuction	24	77.41	8	33.3	12.5

*This data does not include those patients whose management required surgical intervention.

Tab. 5. Wound dehiscence grade, surgical reintervention, mean days to epithelization/closure time (N = 31).

Grade	Patients	Required surgical reintervention		Mean days to epithelization/closure time*
		Yes	No	Mean
none	16 (51.61%)	–	–	–
wound dehiscence	15 (48.38%)	2 (6.45%)	–	34.07
grade I	9 (29.03%)	0	9 (100%)	32
grade II	5 (16.12%)	1 (20%)	4 (80%)	45.4
grade IIIa	1 (3.2%)	1 (100%)	0	150†

*This only includes those patients that did not required surgical management.
†This patient eventually required surgical intervention as depicted on the text.

maining patients. Dressing changes were necessary in only two cases: one switched from alginate to pirfenidone, and the other from polyurethane patch to alginate, based on wound characteristics (Tab. 6).

Preoperative biochemical variables, including leukocyte count, hemoglobin, and albumin, showed no statistical significance in predicting wound dehiscence or epithelialization time (P = 0.302, 0.706, 0.191, respectively). However, preoperative BMI was marginally associated with wound dehiscence (P = = 0.095) and showed a weak correlation with prolonged epithelialization time (Pearson correlation 0.206). Preoperative weight for brachioplasty demonstrated a low correlation with epithelialization days (Pearson correlation 0.240) but was not significantly associated with dehiscence (P = 0.368). The type of bariatric surgery was also unrelated to both outcomes (P = 0.368, 0.450).

Conditions such as hypertension (P = 0.617), diabetes (P = 0.622), and thyroid disease (P = 0.617) had no sig-

Tab. 6. Type of dressing employed for the treatment of wound dehiscence (N = 15).

Dressing employed	No	%
calcium alginate	9	60
pirfenidone	3	20
hydrogel	1	6.66
silver polyurethane patch	1	6.66
sulfathiazole	1	6.66

Tab. 7. Risk estimate for patients who underwent liposuction or a combined procedure.

	Odds ratio	95% confidence interval	
		lower	upper
with liposuction	2.571	1.354	4.884
combined procedure	1.5	0.733	3.068

nificant relationship with wound dehiscence, and all were controlled preoperatively. Previous smokers (N = 3) experienced prolonged time to epithelialization, though without statistical significance (P = 0.564). All patients had ceased smoking by the time of the study.

Extended brachioplasty showed the highest incidence of wound dehiscence (100%), though the correlation with other brachioplasty types was weak (P = 0.103). Patients who underwent combination procedures had a higher rate of dehiscence (57%) and longer epithelialization times compared to those who did not (41 vs 15.75 days), with mastopexy leading to the longest recovery time (mean 53.75 days). Additionally, 85% of patients who had liposuction alongside Brachioplasty experienced more frequent dehiscence and longer epithelialization (28.6 vs 12.5 days), both with statistical and near-statistical significance (P = 0.021, P = 0.10, respectively). Odds ratios for liposuction and combination procedures are presented in Tab. 7.

Discussion

Although aesthetic procedures in MWL patients have become an area of increasing interest for plastic surgeons, few studies on arm reconstruction have been published, particularly those describing complications in the post-bariatric population. Skin quality, comorbidities, and unique factors regarding this patient population pose a significant risk for wound dehiscence. Studies demonstrate specific histopathological skin changes, which could explain the increased wound complications compared to patients who lost weight through diet and exercise. These findings include interstitial fibrosis, fat necrosis, vascular alterations, chronic inflammation, dermal thinning, and abnormal collagen deposition, among others [7,15–17]

In previous studies, Aljerian et al. reported a dehiscence rate of 6.89% [5]. However, they did not distinguish between post-bariatric and non-post-bariatric patients and included studies with varying degrees of dehiscence, ranging from 0% to 33.3% [5]. Gusenoff et al. reported a total complication rate of 40.4%, which included hematoma, seroma, dehiscence, and infection, attributing 22.5% to wound dehiscence in the arm [13]. Marchica et al. reported a 50% wound complication rate, with DWH extending beyond 3 weeks in 26.8% of the studied population [5]. Capella et al., in one of the largest series published (N = 600), reported skin dehiscence in 26% of patients, making it the most frequent complication after brachioplasty [18]. None of these studies included a grading scale for reporting wound dehiscence. In our study, we included all types of wound dehiscence as classified by the SGSSWD, even if this increased the number of reported cases.

We also used the number of days to epithelialization/closure to describe the period between the appearance of wound dehiscence and complete healing, without subcutaneous tissue exposure. Previous studies have not succeeded in defining delayed wound healing as an independent variable, which may have contributed to underreporting bias [8].

In our center, brachioplasty with concurrent liposuction is no longer routinely performed in post-bariatric patients due to concerns about the vascular compromise of the flap and the questionable quality of the skin envelope, which could result in higher rates of wound dehiscence and delayed wound healing, as shown in our study population. While studies have demonstrated its safety in MWL patients without significant complication rates, wound dehiscence still occurs more frequently in those who undergo liposuction [19]. In his paper, De Runz et al. observed outcomes of liposuction-assisted brachioplasty, reporting a global complication rate of 56.1%, with wound dehiscence defined as starting from 1 cm and a global rate of 9% [20]. Although results from previous studies are mixed, we recommend careful patient selection for arm liposuction, especially in post-bariatric patients, based on the analysis done in this study.

Regarding combination procedures, we could not determine with statistical significance whether there was a notable difference in wound dehiscence rates between combination procedures and brachioplasty alone. However, as mentioned in the results section, there is a higher wound dehiscence rate associated with concomitant mastopexy, which could be related to unassessed variables in this study (such as the need for an assistant and assistant technical

skill, longer operative times, etc.). Surgeons should carefully select patients for combination procedures, as other studies have also demonstrated a higher risk of overall complications when other post-bariatric reconstruction procedures are performed simultaneously with brachioplasty [13,18]. This should be discussed during informed consent preparation, as a significant proportion of our post-bariatric patients seek to minimize trips to the operating room by combining procedures.

Based on the data obtained from this study, treatment for this challenging area should be based on a thorough analysis of the wound. Frameworks such as the Triangle of Wound Assessment can be valuable for evaluating and guiding plastic surgeons in selecting the optimal approach for wound treatment since there is a gap in wound management standardization in plastic surgery procedures [21]. Additionally, the accurate categorization of wounds using classifications that facilitate seamless communication among physicians will play a pivotal role in better-analyzing complications and improving clinical management strategies. For this reason, we consider the SGSSWD a useful and straightforward tool to categorize complications and standardize studies of this type [12].

It is important to note several limitations of this study. The first is the sample size, which may compromise the study's power, as an important number of patients do not meet the clinical criteria required for inclusion in our institution's reconstruction protocols. As a study conducted at a single academic center, the applicability of findings to other settings might be limited. Future studies should include additional centers in our country managing similar populations. Another limitation is the inability to compare the various techniques used for brachioplasty, particularly modifications that could reduce tension at the closure site. We also believe that the use of liposuction in combination with technologies aimed at minimizing tissue trauma could potentially reduce the risk of complications. However, in our public hospital setting, the use of such technologies is not feasible. Finally, a case-control study that includes both post-bariatric and non-post-bariatric MWL patients and investigates risk factors could help delineate differences that increase the risk of complications in this population.

Conclusion

As we observed, certain unique factors are significantly associated with the frequency of wound dehiscence in patients undergoing brachioplasty after massive weight loss. Therefore, it is essential to optimize factors that could negatively impact wound healing. The plastic surgeon should carefully consider whether to perform complementary procedures such as liposuction and other combined surgeries in a single session to avoid increased postoperative morbidity. Future studies should focus on accurately describing wound-related complications and provide clear reporting to improve aesthetic outcomes, reduce re-interventions, and enhance patient satisfaction. Describing preoperative planning conditions, outcomes, and management strategies will help develop approaches to diminish dehiscence and delayed wound healing times in this patient population. Further research should focus on understanding changes in wound healing in the post-bariatric population and consider safety measures to improve postoperative outcomes as more patients undergo this type of reconstruction.

Ethical Approval

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients for being included in the study. This consent covered the retrieval of electronic record data and the use of pre- and post-operative photographs for scientific purposes.

Conflict of Interest

Dr. Rojas-Gutiérrez and the co-authors of this paper have no conflicts of interest to disclose.

Funding

The authors did not receive support from any organization for the submitted work.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author on request.

Previous presentations

The previous paper was presented at the International Society of Plastic Surgeons World Congress 2024 in Cartagena, Colombia by Dr. Claudio Daniel Rojas Gutiérrez

Author Contributions

All authors included in this study contributed to its conception and design. Claudio D. Rojas Gutiérrez conceived the original idea, collected the data, and performed the analysis. The first draft of the manuscript was prepared by Piero Carvallo Maiocco, Marisol Gutián González and Erick Zúñiga Garza. Fanny Stella Herrán Motta and Eduardo Camacho Quintero, two of the surgeons involved in the study, contributed to the preparation of the methodology and evaluated the validity and accuracy of the data. Jorge Said Haro Cruz finalized the revisions and editing.

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Submitted: 2. 8. 2025
Accepted: 3. 9. 2025