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Reconstructive

Panniculectomy: Practical Pearls and Pitfalls

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Summary: Panniculectomy is an increasingly common operation, given the current obesity epidemic and the increasing prevalence of bariatric surgery. At first glance, it could be considered a technically simple operation; however, this procedure can be fraught with complications, given the patient population and high demands placed on compromised abdominal tissue. Sufficient attention must be given to the nuances of patient optimization and surgical planning to maximize safe and ideal outcomes. We highlight our practical tips when performing standard or massive panniculectomy for preoperative optimization, intraoperative techniques, and postoperative management to reduce complication and maximize outcomes of this procedure from a surgeon's and a patient's perspective. *(Plast Reconstr Surg Glob Open 2020;8:e3029; doi: 10.1097/GOX.0000000000003029; Published online 14 August 2020.)*

INTRODUCTION

The incidence of obesity has been steadily increasing over the past decade, with a significant burden to both patients and the healthcare system as a whole. According to the Centers for Disease Control, the prevalence of obesity in the United States is approaching 40%, with an associated cost of $147 billion per annum.[1] To parallel this trend, there has been a concomitant increase in the incidence of bariatric surgeries performed in the United States, with over 200,000 being performed each year.[2] While bariatric surgery is successful in treating obesity and metabolic dysfunction, patients are often left to deal with the excess abdominal skin and subcutaneous tissue left behind after weight loss. In addition, even for those who have not undergone a bariatric surgery, there are functional impairments that can result from excessive skin and subcutaneous tissue, including ulcerations and nonhealing wounds, hygiene issues, rashes, inability to perform activities of daily living, and joint issues, among others. This apron of tissue, the panniculus, is frequently on the lower abdomen but can include the mons pubis, upper abdomen, flanks, and back. The panniculectomy procedure is performed with the intention of surgically removing this excess skin and subcutaneous tissue to improve the patient's function and to decrease morbid sequelae such as those mentioned previously.

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The panniculectomy is a theoretically simple procedure that can be performed expeditiously and adequately with standard planning, and therefore, it is often marginalized in its nuances. However, due to the patient population requesting panniculectomy, and the demands placed on the tissues, there is a high rate of complications and an even a higher rate of suboptimal outcomes, which in turn demands greater attention to perioperative planning and execution than standard.[3] While the patient is very likely to see benefit from panniculectomy, and receive high satisfaction, there is an effect from even the smallest complications on patient outcome, satisfaction of both the patient and surgeon, and health care burden.[4] Adherence to the basic surgical and medical principles presented in this article can improve the quality of experience for both patient and surgeon alike.

What follows are practical pearls that the senior author uses to improve operative outcomes for panniculectomy in the preoperative, intraoperative, and postoperative setting. This list is by no means comprehensive but highlights areas of focus in specific regard to the panniculectomy patient that have evolved in the senior author's practice over time based on experience and evidence-based literature review.

PREOPERATIVE CONSIDERATIONS

It is important to understand that panniculectomy is a completely elective procedure that should not be carried out until the potential for success has been fully maximized. Patient selection and *pre*-habilitation are of

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extreme importance when planning any body-contouring procedure.[5–7] These patients often have a multitude of associated comorbidities, as well as dependence on multiple medications, to manage chronic conditions. It is important not only to be aware of these conditions, but also to have a frank conversation with the patient about the risk added to surgical intervention and the potential benefits of optimizing modifiable risk factors. Although all comorbidities are important, a few will be highlighted in this section.

Substance Abuse

Important factors related to substance abuse include exposure to smoking/nicotine, alcohol consumption, and the use of other illicit substances. The effects of nicotine on wound healing are well understood and documented.[8–11] It has been shown that 1 cigarette decreases peripheral blood flow by 42%.[12] These effects are further compounded by the size of the patient and by any devascularization that may take place intraoperatively. Thus, it is not recommended to perform a panniculectomy on any patient who is actively smoking or who has a significant exposure to secondhand smoke. It has been demonstrated that 4 weeks of abstinence from nicotine both pre- and postoperatively can help mitigate effects of wound healing on postoperative recovery.[8,13]

Diabetes Mellitus

The implications of diabetes, particularly higher rates of wound healing complications and an increase in infection risk from decreased immune response to surgical stress, are well known.[6,7] It is commonly accepted that hemoglobin-A1c above 7.5 mg/dL is correlated to increased wound healing complications. It is recommended that both behavioral and medical interventions be undertaken to control blood glucose to a level of ≤7.4 mg/dL within 30–60 days of operation, with a goal of 6.5 mg/dL, or less.[14] Perioperative glucose control is likewise important, with a goal of maintaining blood glucose below 200 mg/dL for the duration of their recovery.[15]

Nutrition and Weight Loss

Many patients presenting for panniculectomy are involved in a massive weight loss. It is common practice to delay panniculectomy until weight has been stable for six months, or more; however, in highly motivated patients, panniculectomy can be performed to improve the patient's ability to exercise, facilitating a continued weight loss. There are a multitude of weight loss strategies patients may employ, all of which affect patients and their suitability for surgery differently. Surgical weight loss solutions are the most extreme on this spectrum and can be restrictive (such as a gastric band) or malabsorptive (such as a roux-en-Y gastric bypass), which impact a patient's nutritional status differently.

Common nutritional deficiencies of patients include iron, vitamin B_{12}, calcium, thiamine, zinc, and fat-soluble vitamins (A, D, E, and K). Many patients, especially postoperative bariatric patients, are also protein-deficient. A protein intake of at least 70 g/day is recommended for these patients; however, subjective intake of protein (such as albumin and prealbumin) is imperfectly correlated with laboratory measures of nutritional status.[16,17] Deficiencies in nutrients have been associated with delayed wound healing, bleeding, and even encephalopathy.[7,18,19] It is our practice to address any micronutrient deficiencies in patients with nutrition supplementation, upon confirmation from laboratory findings, and we would ensure that our patients have a preoperative serum albumin of >3.5 g/dL before operation.

Medical History

As with any patient, the medical history and current medications of patients presenting for panniculectomy should be reviewed in detail to identify any areas of potential optimization. Areas of focus should be medications that alter surgical risk (eg, β-blockers, anticoagulants, antiplatelet agents) or those that could be adjusted to optimize outcomes (micronutrient supplementation, insulin/antihyperglycemics, etc.). Additionally, it is important to be aware of any nonprescribed medications and supplements, as their actions have been linked to a number of unanticipated surgical effects, including bleeding, immunosuppression, hypertension, arrhythmia, medication interactions, and more.[20,21] In general, it is prudent to stop all nonprescribed herbal supplements at least 2 weeks before surgery to decrease these complications. Over-the-counter vitamins add minimal risk, but patients should avoid high doses of vitamin E in the perioperative period.[20,22–24]

Another important preoperative consideration is the patient's psychosocial health. The relationship between outcomes after a massive weight loss and psychosocial health have been previously discussed in the literature, and patients with poor coping skills can have a higher rate of complications, or react poorly when complications occur.[25–27] Our protocol to prevent this is to have an open, honest preoperative discussion with the patient about the high risk of complications, detailed descriptions of each complication, as well as anticipated future management. Patients who indicate that they could not handle managing any complications, or give other signs to the surgeon that they are not mentally prepared for surgery, are deferred until they are prepared for the surgery. We do not routinely seek counseling for these patients unless indicated based on discussion with the patient.

Surgical History

Scarring from previous surgery should cue in the surgeon for alterations to blood flow distal to the scar, potential points for decreased soft-tissue mobility, and the possibility of a ventral hernia. Surgical scars should be approached with caution and careful consideration must be given to the incision planned near the scar. Preoperative detection of hernia is of extreme importance.[28–31] Bariatric surgery carries a risk of around 2.4% for development of incisional hernia, up to >15% in high-risk patients.[32] Although concurrent hernia repair and panniculectomy is well described, the presence of a ventral hernia changes the operation and operative goals significantly. The discovery of incidental hernia at

the time of panniculectomy/abdominoplasty has been quoted to be over 5%, making them relatively common.[28] These hernias are typically periumbilical or associated with prior incisions and laparoscopic port sites. Although these can be repaired by the plastic surgeon with a low complication rate, it is safer and more efficient to identify potential hernia sites preoperatively with a thorough physical examination, with possible imaging and general surgery referral/collaboration, as indicated. If a patient has a hernia identified preoperatively, it is managed in a multidisciplinary fashion before panniculectomy. Our preference for small hernias, particularly in patients with a massive, overhanging panniculus, is a laparoscopic hernia repair, with the panniculectomy performed as a second-stage surgery once the patient has healed. Larger hernias may be addressed in a multidisciplinary fashion concurrently with open ventral hernia repair and concurrent panniculectomy.[33–35]

INTRAOPERATIVE CONSIDERATIONS

Marking

The marking for panniculectomy is performed preoperatively, with intraoperative adjustments made as indicated. The patient is marked in the standing position to observe the draping of the panniculus, and the lower incision is marked first. As in abdominoplasty, the low point of the incision should be at least 7 cm above the anterior vulvar commissure to avoid vertical displacement and changes to micturation angle. The marking is then continued laterally and superiorly toward the anterior superior iliac spine, using existing folds as much as possible. The incision should not be placed directly over the anterior superior iliac spine, as this could be a point of potential wound breakdown, nerve injury, and discomfort. The planned incision can appear to be very inferior due to the descent of the tissues; however, this is corrected after excision and suspension. After the lower incision is marked, a provisional upper incision is planned using bimanual palpation to assure that the incision lines will approximate with minimal tension. The patient should then lie supine to confirm markings and the ability to approximate without tension. Prior scars should be included in the resection if possible. If the umbilicus is within the resection markings, it is also planned for resection, which is notified to the patient preoperatively.[36]

If the patient has a great deal of horizontal laxity or epigastric laxity, a fleur-de-lis vertical component is added to address this. Although this addresses superior laxity, it does introduce the added complexity of a triple confluence point. Although the overall complication rate for this is high, as in all panniculectomies, it is similar to traditional panniculectomy except for a higher incidence of infectious complications.[37,38] A provisional pinch test is performed with the patient placed supine to estimate the tissue for excision.

Positioning and OR Setup

The use of specialized equipment, such as a bariatric bed, "garage door" or Hoyer lift suspension, Steinmann pins, and negative pressure wound therapy, should be planned in advance, and the equipment should be made available in the room. In large panniculectomies, we plan for the use of "garage door" suspension with use of overhead retraction. This has been accomplished with the orthopedic trapeze, Hoyer lifts, or the overhead fracture table. After preparing the patient and draping, we suspend the panniculus with 2–4 Steinmann femur fracture pins and elevate it from the overhead crossbar (after confirmation that there were no hernias) (Fig. 1). This has multiple benefits. First, it allows full visualization of the panniculus, which improves accuracy and efficiency. Second, it can minimize intraoperative blood and fluid loss by decongesting the panniculus through gravity. Third, it allows easier estimations of excision by aiding in pinch testing by providing consistent traction.

Electrocautery

Electrocautery has become a mainstay in modern surgery for both surgical efficiency and the ability to concomitantly accomplish dissection and hemostasis. However, it is important to use electrocautery judiciously. Specifically, the skin and dermis should not be incised using electrocautery, as this can lead to coagulation necrosis from thermal injury and subsequent skin breakdown after closure, secondary to loss of viability at the newly approximated

Fig. 1. Images of multiple techniques used for suspending the panniculus to facilitate dissection in larger cases. A, Trapeze. B, Hoyer lift. C, "Garage door" lift.

Fig. 2. Intraoperative example of dilated vasculature commonly encountered in the panniculectomy patient.

skin edges in already tenuous skin. It is recommended to incise the skin sharply with a scalpel through the dermis to preserve the subdermal plexus. Only then should electrocautery be used to continue dissection and achieve hemostasis at select problem areas. This leaves the viability of the skin edge intact for later approximation.

Hemostasis

Although electrocautery is sufficient for many small vessels, panniculectomy patients can have massive dilation of their superficial vasculature (Fig. 2). In many patients, these can be greater than 1 cm in diameter and can contribute to a significant blood loss, loss of operative efficiency, and loss of clear visualization of surgical planes. The senior author's preferred technique is to tie off any vessels greater than 2 mm with silk ligatures, although large clips may also be used for this purpose. While hand tying is less time-efficient than electrocautery, it provides more secure hemostasis and can decrease seroma rates.[39,40]

Managing Deadspace

While it is the norm in abdominoplasty and hernia repair to undermine widely to facilitate easy soft-tissue re-draping, panniculectomy undermining should be significantly more conservative or even nonexistent. The skin is often tenuous secondary to chronic inflammation and dependent edema. Therefore, it is most beneficial to minimize undermining in an effort to maximize vascularity to the skin by maintaining composite tissue for maximal wound healing. The 3 vascular zones of the abdomen were initially described by Huger in regard to abdominoplasty, and this still serves as a strong framework for understanding the vasculature of the abdomen in regard to panniculectomy[41,42] (Fig. 3). These vascular territories, as well as the areas of high lymphatic density, such as the inguinal basin, must be respected and preserved to the maximal extent to prevent wound healing complications. All efforts should be taken to spare skin perforators when encountered to preserve these vascular zones as much as possible.[43]

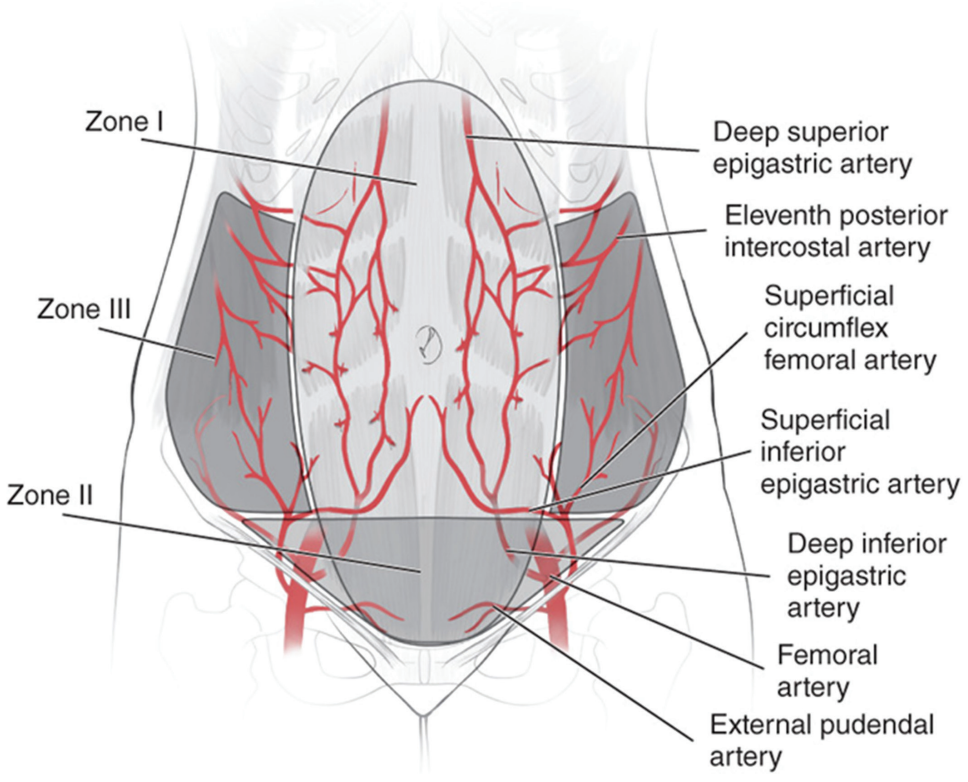

Fig. 3. A drawing demonstrating the Huger zones of vascularity for the abdominal wall. Reproduced with permission from Thieme Publishing.

Fig. 4. Representative preoperative photograph of a patient undergoing massive panniculectomy.

In the uncommon case where undermining in necessitated, progressive tension sutures should be used. Progressive tension suture provides obliteration of extensive dead space, decreases shear stress, and provides tension offloading on the skin closure, which maximizes wound healing potential and decreases scar widening. In addition, it prevents scar migration during healing, which contributes to a more symmetric scar line.[44] Drains are also liberally used to help eliminate deadspace after panniculectomy. Attempts are made to maximize the intracavitary length of the drain while minimizing the length left external to the skin.[45] The senior author's criterion for pulling a drain is for the cumulative output of the drain to be <20 mL over a 24-hour period for 2 consecutive days, consistent with evidence behind volume-based drain removal.[45] The patients are educated about the use of drains, their care and management, and the criteria for removal preoperatively during clinic consultation and consent to minimize confusion postoperatively (Figs. 4, 5).

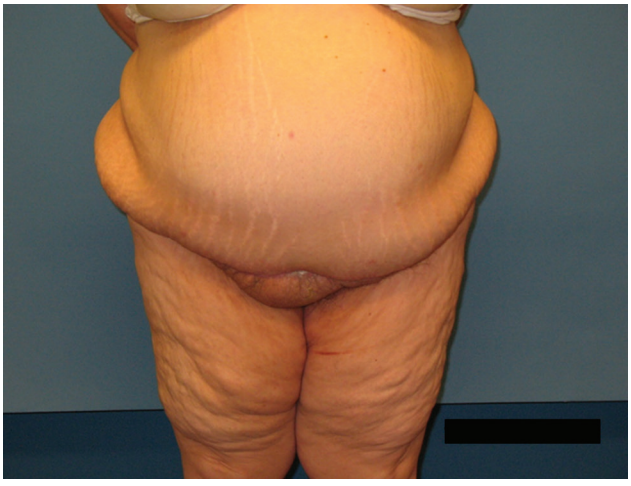

Fig. 5. Representative postoperative photograph of the same patient after negative pressure wound therapy and closed-suction drain removal.

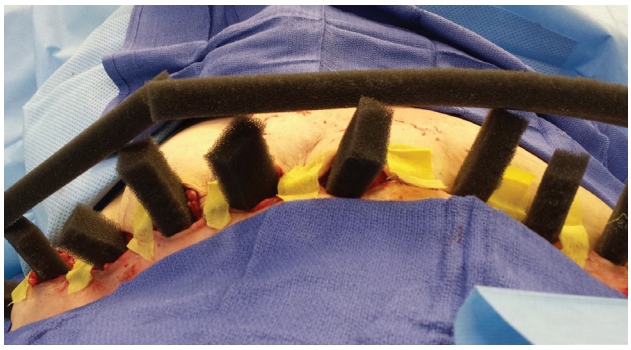

Fig. 6. Image of the "string-of-pearls" negative wound pressure therapy technique to manage the incision in high risk cases.

Negative Pressure Wound Therapy

Incisional Negative Pressure Wound Therapy (NPWT) has demonstrated improved blood flow, decreased edema, improved lymphatic clearance, and improved mechanical splinting for the incision.[46,47] It has been well demonstrated that the use of incisional NPWT can decrease the risk of surgical site occurrences in high-risk wounds through these mechanisms.[46,48–50] In certain cases of profound lymphedema or when the risk of dehiscence or infection is sufficiently high, the senior author will perform a "French fry, string-of-pearls technique": this technique takes advantage of both traditional NPWT and incisional NPWT.[34,51,52] Five-centimeter portions of the incision are closed intermittently, and these closed portions are separated by 5-cm open portions (Fig. 6). The skin of the closed portions is protected from the foam sponge with nonadherent gauze, and vertical struts of polyurethane foam are inserted as wicks into the open portions. Outside the skin, the wicks are connected with a large bridging bar of foam to make a cohesive apparatus, which is then sealed air-tight and connected to suction continuously at 125 mm Hg. The general concept is to convert a large wound into multiple small wounds, which heal secondarily (**see Video 1 [online]**, which summarizes techniques and pearls used for successful panniculectomy).[34,51,53] By using the "French fry, string-of-pearls technique," the senior author converts the incision into a wound with a "controlled dehiscence." By taking advantage of the vertical struts of this technique, the NWPT is able to more aggressively drain the accumulating fluid. At the same time, this can address the high rate of surgical site occurrences, such as dehiscence and infection, proactively by allowing the intervening areas to heal

secondarily. The senior author has used this technique in appropriately high-risk patients, with good success.

POSTOPERATIVE CARE

Abdominal Compression

While abdominal binders have not been shown to decrease the incidence of seroma, many patients find the support to be comfortable and reassuring.[40] It also aids in offloading gravitational tension from the incision.

Venous Thromboembolism Prevention

Panniculectomy patients are at a high risk for venous thromboembolism for a multitude of reasons, such as long operative times under general anesthesia, large area dissection, and prolonged periods of decreased activity postoperatively.[54] In a large-volume National Surgical Quality Improvement Database analysis of body-contouring patients, the venous thromboembolism rate was 0.56%, with significant predictors found to be age older than 45 years, obesity, BMI > 35, hospital admission, and trunk-contouring procedures.[55] Patients should be risk stratified using the 2005 Caprini score preoperatively.[56] They are referred to a hematologist for further evaluation as indicated by personal or family history.

Sequential compression devices are used before induction of anesthesia. These are used continually in the postoperative period until the patient is discharged from the hospital. Additionally, ambulation is encouraged at least once on the day of surgery and 5 times daily thereafter. Patients receive chemoprophylaxis with postoperative weight-based low-molecular-weight heparin injected subcutaneously starting on postoperative day 1.[57] Our weight-based dosages for chemoprophylaxis using low-molecular-weight heparin range between 30 mg daily up to 40 mg twice daily depending on the weight of the patient and institutional recommendations. This has not been shown to increase the risk for reoperative hematoma, but body-contouring procedures have been shown to be independently predictive of hematoma requiring reoperation.[58] Chemoprophylaxis is discontinued upon discharge except in unique circumstances, such as in preexisting hypercoagulable state or mobility issues.

Pain Control

Multimodal analgesia is used in all panniculectomy patients. A baseline regimen of pain medication has been adapted from our abdominal wall reconstruction cohort as follows: acetaminophen, 1000 mg every 6 hours (if no hepatic history); celecoxib, 200 mg every 8 hours (if no cardiac or renal history); gabapentin, 300 mg every 8 hours (if age <65 years, normal creatinine clearance, and no obstructive sleep apnea); and oxycodone, 5 mg every 4 hours as needed for breakthrough pain only. This has been found to minimize oral morphine equivalents in our patients and provide good postoperative pain control.

CONCLUSIONS

Panniculectomy is a commonly performed operation to relieve functional symptoms from an excess of abdominal skin and subcutaneous tissue. While it is overwhelmingly successful in accomplishing its functional outcome, it is wrought with a high complication rate resulting from the health of patient and the relatively high demands placed on compromised tissue. Our experience presents practical considerations and modifications to all phases of care that can be used by all plastic surgeons to decrease complications, both in number and severity, and to improve outcomes and satisfaction.

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