

CHAPTER 42

PLASTIC SURGERY AFTER LOSS OF MASSIVE EXCESS WEIGHT

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Plastic surgery is a logical and humane concomitant to bariatric surgical procedures which induce massive excess weight loss. It includes, among others as may be individually required, abdominoplasty, brachioplasty, liposuction, reduction mammoplasty, mastopexy and lower body lift. Various operative and other details of these plastic procedures, as well as informed consent risks, benefits, possible complications, and implications, are presented.

Increasing numbers of morbidly obese persons are losing massive amounts of excess weight, due to improved short-term and long-term bariatric surgical results. While this permits them to reap many of the medical, physical, social, psychological and economic benefits of bariatric surgery, they are often left with extremely redundant masses of skin, fat and other bodily distortions in various anatomic locations.

In turn, these distortions may lead to, or exacerbate, associated unique functional, psychosocial and medical co-morbidities. These co-morbidities can impair the otherwise successful bariatric surgery patient's quality of life and activities of daily living. In order to fully benefit from successful weight loss, additional surgical correction may be required.

This post-bariatric surgical co-morbidity issue is similar to that following radical mastectomy where breast reconstruction has become recognized as a humane necessity. Like these breast cancer victims, recovering victims of morbid obesity often require corrective surgery. Such surgery should be an accepted part of the surgical "package" or at least available on a reasonably permissive, as required, basis.

This chapter presents accepted approaches to surgically correcting various bodily distortions, by means of surgery with or without liposuction. The anatomic areas discussed in detail include the abdomen, breasts, arms and thighs, which are most frequently requested by patients for correction following surgically-induced massive weight loss.

ABDOMINOPLASTY

The Abdominal Pannus and Associated Co-morbidities

The hanging abdominal apron can be problematic after loss of excess weight. It may be associated with periodic or continuous inflammation (panniculitis, cellulitis, intertriginous dermatitis, folliculitis), skin abscesses, lymphedema, excoriation and ooz-

ing, gangrene, low back and lower extremity pain, ambulatory limitation, difficulties at toilet, interference with sex, personal hygiene problems including unpleasant odors and inability to adequately self-cleanse, inability to find clothes to fit well, self-consciousness, altered body image and psychiatric disorders, difficulties in physical activity, hypertrophic-keeloid scars, striae distensae, cutis fragilis and interference with abdominal respiratory function. Diminished abdominal wall integrity from attenuated fascia and muscles and umbilical and ventral hernias are frequently associated.

Abdominal panniculectomy and reconstructive abdominal surgery may be performed, in order to alleviate the associated co-morbidities (Table 1). The surgery will improve function and body contour. Lipectomy is not offered as a weight loss procedure by itself, since such surgery, like abdominal liposuction, is inadequate for weight loss.

Abdominal Panniculectomy

The panniculectomy involves excising the abdominal pannus. It may also be performed in conjunction with primary bariatric or other surgery, based upon the surgeon’s judgement and experience, but this adds 1½ hours to procedure time and increases risk of requiring blood transfusion. The wound problem risks increase about ten times those for primary bariatric surgical procedures alone. However, combined surgery produces a better cosmetic result, some additional weight loss, as well as the potential advantages of improved pulmonary function and ambulation postoperatively. We rarely, and highly selectively, employ it concomitantly with primary bariatric surgery.

Reconstructive Abdominoplasty

In addition to panniculectomy, reconstructive abdominoplasty usually includes anterior abdominal wall muscle and fascial plication

TABLE 1. ABDOMINAL PANNICULUS AND ASSOCIATED CO-MORBID ICD9CM CODES

<i>Diagnostic Indication</i>	<i>ICD9CM Code</i>
Abdominal mass, diffuse or generalized (e.g. large overhanging pannus)	789.3
Hypertrophic & atrophic skin condition (e.g. permanent overstretching of abdominal wall)	701.6
Fat pad (panniculus adiposus)	278.1
Unspecified disorder of skin & subcutaneous tissue	709.9
Panniculitis, other site (e.g. abdomen)	729.39
Panniculitis affecting back (e.g. low back pain)	724.8, (724.2)*
Lymphedema, acquired, chronic	457.1
Skin abscesses abdominal wall	682.2
Dermatitis, unspecified cause (e.g. crease dermatitis)	692.9
Uncontrollable intertrigo	695.89
Skin rash, non-specific eruption	782.1
Heat rash	705.1
Skin scar, keloid, hypertrophy	701.4
Cicatrix, scar, fibrosis of skin	709.2
Panniculitis affecting back including sacrum	724.8
Abnormal or absent skin sensation	782.1
Striae distensae	701.3
Diastasis recti of abdominal wall	728.84
Umbilical hernia	553.10
Epigastric hernia	553.29
Ventral hernia unspecified (postoperative or recurrent)	553.20, (553.21)*

*Code numbers in parentheses correspond with the equivalent Diagnostic Indication listings in parentheses.

(Table 2). It may also include suction lipoplasty to improve the reconstructed abdominal wall contour as well as umbilical or ventral herniorrhaphy or other intra-abdominal procedures.

While Savage generally required a 2-year interval,¹ we inform our patients that we would evaluate a request for a “tummy tuck” 18 or more months following bariatric surgery, when their weight loss curve has been flat for 3 months or more. We also explain that the patient must definitively request this surgery, since, while there are associated co-morbidities, it is usually a less essential entity than the earlier bariatric surgery.

The post-bariatric surgical interval is important for a more desirable result. The weight loss having become maximal, we have a smaller mass of fat to remove than earlier, as well as more intra-abdominal domain available for additional fascial and muscular wall imbrication. Equally important, the patient should have largely recovered his or her nutritional status following the weight loss.

Other Procedures

Postoperative bariatric surgical patients have a bell-shaped weight loss curve for each

procedure and each surgeon. It is usually not possible to correctly predict where each patient will fall on the respective curve. Therefore, some patients, at the time of abdominal wall reconstruction, may wish to take advantage of this opportunity, where acceptable to all parties, to have their primary bariatric surgery modified with the intent of additional weight loss. For example, “short limb” has been converted to “distal limb” gastric bypass, or peri-pouch rings have been added, narrowed or replaced, in conjunction with this surgery.

In some cases, plastic surgeons have during the procedure tunneled breast implants superolaterally through the midline incision, thereby avoiding infra-mammary incisional scars. Urologic procedures may also accompany the lipectomy. Selectively, where documented indications of medical necessity are present for abdominal hysterectomy, we have added that surgery to the operative plan. Other procedures which have been added include bilateral tubal ligation, breast reduction or reconstruction, wedge liver biopsy, hiatal herniorrhaphy, bilateral truncal vagotomy, cholecystectomy, appendectomy and mesh as may be required for ventral herniorrhaphy. Other “tucks” elsewhere on the body

TABLE 2. ABDOMINAL WALL RECONSTRUCTION

<i>Abdominal Wall Surgery</i>	<i>CPTCode</i>
Abdominoplasty (including Plication of the rectus muscles)	15831
Abdominal Wall Mass Resect	22999
Exploratory Laparotomy	49000
Umbilical Herniorrhaphy	49585, 49587*
Ventral Herniorrhaphy, primary	49560, 49561*
Ventral Herniorrhaphy, recurrent	49565, 49566*
Mesh Implant Ventral Hernia**	49568
Unlisted abd, peritoneum, omentum	49999
<i>Abdominal Wall Surgery Modifiers</i>	<i>CPT Code Suffix</i>
Unusual Procedural Services	-22
Multiple Procedures (e.g. Hernias)	-51
Distinct Procedural Service	-59
Two surgeons, different procedures	-62

*Incarcerated or strangulated hernia.

**Abdominal mesh implants are reported separately, in addition to the ventral herniorrhaphy.

may also be performed, but concern for early postoperative limitations of function may cause some restraint.

It is a serious matter of judgement by the surgeon as to how much surgery and anesthesia time the patient can handle without significantly increasing operative risk. We prefer to err on the conservative side, but, with the patient's full knowledge and acceptance of potentially increased risks, have sometimes provided more comprehensive surgery on a selective basis.

Documentation

The indications for panniculectomy or reconstructive surgery require documentation. Such documentation serves as the basis for letters to the medical insurer requesting surgical coverage. It is also prudent risk management. Therefore, it is wise to list all associated clinical symptoms and signs in the patient's History and Physical Examination. It is also wise to refer to them again in the Operative Note. Reiteration of the indications in the Discharge Summary is also prudent. The same applies to indicated accompanying procedures.

Photography

Medical insurers have been known to refuse payment for abdominal wall panniculectomy or reconstruction for many reasons, one being lack of preoperative photographic evidence. It is advisable to have an office routine which includes adjunctive preoperative abdominal photographs. Some insurers require that the pannus hang down sufficiently that it obscures the pubic area. Others reportedly look for intertrigo or other signs of inflammation under the pannus. Patient photos, therefore, include front, side and under-surface views.

It is wise to have all photos in the patient record preoperatively in the office. Polaroid or digital cameras provide convenience and are usually preferred over deferred-development modalities, although later development may offer better quality

Informed Consent

Our Informed consent includes educational material.² Table 3 is a "Fact Sheet" which we provide to patients to read and sign, countersigned by a witness and the surgeon.

TABLE 3. FACT SHEET FOR PANNICULECTOMY WITH RECONSTRUCTION ABDOMINAL WALL/VENTRAL HERNIA SURGERY PATIENTS

Large patients, and those who have lost much weight, often have an apron of skin and fat on the front of their abdomen. The medical name for this apron is panniculus; the surgery to remove it is called panniculectomy, dermatolipectomy, abdominoplasty or a "tummy tuck". "Tummy tucks" are done for infections, itching, pain, odors, low back pain, difficulty with urination or breathing, sex limitations, reaching areas for proper hygiene or finding clothes to fit. It is major surgery although less than, say, a gastric bypass.

In patients who have had previous obesity surgery, the scar for a "tummy tuck" usually goes from the bottom of the breast-bone down to the pubic bone. There it meets a second, horizontal scar just above the pubic hair area to form what looks like an upside-down letter "T." To make this "T," the skin and fat are freed up from the front of the abdomen; then, a large triangle-like area of extra skin and fat from each side's central area is carefully removed. The remaining tissue is stitched to the front of the abdominal wall and to itself.

The "belly button" is sometimes removed since its deep blood supply may have been divided as part of the earlier obesity surgery. Some surgeons believe that this loss of blood supply increases its chances of dying or becoming infected after being re-planted with this "tummy tuck" surgery, and, therefore, recommend removing it.

A ventral hernia is a defect or weakness of the front of the abdomen allowing intestine or other abdominal contents to bulge outwards. Hernias are repaired mostly for the pain they cause as well as for the risk of trapping or strangling intestines within them. Hernias usually get larger and painful. To repair a hernia, we sew the weak abdominal wall together with strong stitches which pull together extra tissue. This can leave excess, sometimes unsightly, skin and fat above the hernia repair. This is another good reason to do a "tummy tuck" with the hernia repair.

In addition, when the "tummy tuck" is performed, the surgeon can usually reach a lot more floppy tissue up and down the entire front of the abdomen. Therefore, the surgeon usually pleats most of the deep muscle and its fibrous coverings on the front of the abdomen together.

This makes the hernia repair, as well as the front of the abdomen, even stronger. It also makes the waist smaller, which allows even more skin and fat to be removed for the “tummy tuck.”

Since the abdomen is different on each side and the patient is not standing during the surgery, the skin and fat remaining after the “tummy tuck” are not always equal on each side; it may even hang or bulge somewhat with standing. Especially if there is more weight loss after the surgery, an apron may form again on the front of the abdomen, but much smaller than the original one. The weight lost by removing the apron can also be regained later. Other internal surgery, such as intestinal relocation, banding or cutting the nerves to the stomach, hysterectomy, or tying tubes may be performed. This may increase the risks of the surgery, which become more like those of earlier obesity surgery.

Since the tummy tuck involves raising considerable skin off the front of the abdomen, some of the small nerves to the skin are cut. This may cause numb or extra-sensitive areas in this skin for weeks or months. Different people have different amounts of pain after the surgery and it is not possible to predict how much pain a particular person may have but surgeons are experienced in providing effective pain medicine.

The surgery may cause a feeling of tightness for the first few weeks or months. Due to the pleating of the front of the abdominal wall, the intestines have less room in the body cavity and tend to push the diaphragms up into the chest. This can make it harder for part of the lungs to inflate which can cause a fever, even pneumonia, especially if the patient does not breathe deeply enough. It is, therefore, important to breathe deeply, using the chest muscles, after the surgery and breathing exercise equipment provided.

Wounds heal better with good nutrition. It is important to take protein and other recommended nutrition. Low back pain can improve after a “tummy tuck” but not always. Infections may happen even with antibiotics and need to be drained or stitches removed; antibiotics prescribed need to be taken as instructed. Also, scars may widen or curve due to tight skin pulling to one side, including the “belly button” if it is replanted. Liquid fat may discharge or make hard areas under the skin. Sometimes, blood or serum may discharge or collect under the skin and sometimes need to be removed.

Patients who have any problem with the surgery after going home, should call the office soon and not wait 3 or 4 days.

Since weak tissue is often present on the weak abdominal wall, hernias may sometimes come back, especially if the patient is still large. When the edges of the hernia defect do not come together or the tissue in the repair seems weak, plastic mesh may be needed; this may increase risk of infection with need for mesh removal later. Adhesions usually form after surgery;

very rarely, they cause the intestines to be kinked, needing emergency surgery for “locked bowels,” also called intestinal obstruction.

The surgery pulls up on the groin and pubic skin and fat, in order to sew up the cut skin across the bottom of the abdomen. This can cause some parts of the genital area to also be pulled up, making it a little difficult or different for some patients to pass urine (after the catheter is removed), and the tissues may become swollen for a time. Fluid may collect under the skin flaps and need to be drained by a needle, tube or directly. Some of the skin, especially near where the vertical and horizontal skin wounds come together, may lose its blood supply and need to be removed; when this occurs, it usually heals together afterwards but may require more frequent dressing changes or, rarely, additional surgery.

The possible complications patients face with obesity surgery are also present. These risks, although small, include pneumonia, lung collapse, blood clots in the pelvis or lower extremities, these clots possibly traveling to the lungs. Complication rates vary between centers in patients who have had previous obesity surgery, from 10% to 50%, depending on the different population characteristics of each center.

Date: _____

Signature of Patient: _____

Examiner’s Signature: _____

We also give a written *true-false examination* preoperatively, to make sure that the patient understands the information. The exam serves as further evidence that the patient does not have false beliefs and does not have unrealistic expectations from the surgery.

Preoperative Work-up

In addition to the usual blood count, screening chemistry panel, coagulation studies, electrocardiogram, chest x-ray, urinalysis and other indicated studies, we insist on endoscopically and radiographically studying the primary bariatric operation. It is a wasted opportunity to perform reconstructive abdominal surgery only to later find the patient regaining weight due to staple-line disruption, ring erosion or other “silent” problem, which may have been addressed at the time that abdominal wall reconstruction provided intraperitoneal access. Certain findings may even lead to a pre- or

intraoperative decision to defer reconstruction, e.g. to attend to a gastro-gastric fistula.

Preoperative Bowel Prep

Preferences range from no bowel prep to an extensive one. Some surgeons prep their patients just as for preoperative primary bariatric surgery with a chilled, flavored polypropylene glycol solution (or Magnesium Citrate if a capacity problem), clear liquids the day before surgery and NPO after midnight. This is felt to reduce the chances of hard stool in the colon causing postoperative problems and also to lower the infection rate, particularly if intestinal relocation or similar intervention is to be performed. Prophylactic parenteral antibiotics are usually employed immediately preoperatively; later, oral antibiotics are continued by most surgeons for 3-4 weeks, to reduce risks of late postoperative infection, although Soundararajan³ reports good results without them.

Risks, Complications and Implications of the Surgery

Peri-operative complications have been reported to occur in from 13%³ to 47%⁴ of patients who had at least an abdominoplasty after bariatric surgery. One study found that smokers had twice as many complications with skin necrosis, wound dehiscence or infection, as non-smokers.⁵ Another study related similar complications with hypertensive and elderly patients.⁶

DESCRIPTION OF THE ABDOMINAL RECONSTRUCTIVE OPERATION

Operating-room Set-up and Preparation

The preoperative radiographs should be present. If performing additional revisional surgery, they are especially important; however, we like to make final re-confirmation that

the radiographs, sometimes obtained late on the day before surgery, are indeed as reported.

A Foley catheter is introduced into the bladder, since, as a result of surgical elevation of the suprapubic fat pad, the tissue in the urethral area is likewise pulled forward and can cause early postoperative urinary retention.

Whereas a plastic, adherent wound drape is used for primary bariatric surgery, none is used for abdominal reconstructive surgery. The drape would obscure scar tissue and make the skin considerably less compliant, particularly for measurement and other flap-fashioning maneuvers. This is particularly important when marking the cut-to-fit flaps as described below.

For those patients with giant panniculi, we employ an orthopedic frame stand together with 3 Steinman pins and holders attached with kerlix gauze to the top of the frame (Figure 1). First we prep the pannicular apex and then pierce this sterilized area with the Steinman pins, using them to hoist the entire panniculus which then becomes completely accessible for the thorough prep which follows. Giant panniculectomy procedures should be avoided, until some experience is obtained with the moderate and large ones.

Patient Positioning and Prep

The patient, under general endotracheal anesthesia, is placed supine with folded sheets



FIGURE 1. Giant abdominal panniculus, prepped, draped and suspended by Steinman pins on an orthopedic frame.

under the lumbosacral area and buttocks, elevating them somewhat off the table. This should allow the prep to extend well around the patient postero-laterally from the mid-thigh to mid-chest level (i.e. “high-wide-and-hand-some”), since the skin pulled anteriorly often arises rather far postero-laterally and, unless so prepped, may result in potentially contaminated skin entering the operative field during surgery. Double sterile towels are also used between the table and the sides and buttocks, followed by widely-placed towels and drapes.

Marking the Abdominal Wall

In a sterile fashion, the midline and suprapubic incisions are marked with wooden swab sticks dipped in methylene blue; this is used since our commercially available “pens” usually clog before completing the marking. When only the pens are available and clog, we remove and hold the pen’s ink-soaked fiber core with a clamp to complete our skin markings.

A gentle, symmetrical, suprapubic curve is drawn within the “bikini zone” and then extended horizontally to the most lateral extent of the inferior abdominal fold but usually no more lateral than the posterior axillary line. The line is drawn somewhat away from the base of the skin-fold which is usually thinner and of poorer quality for suturing and healing.

In certain instances, when the panniculus arises essentially from the lower abdomen, it may be excised by use of the horizontal incision only; these incisions have been described suprapubically and also at the umbilical level.⁷ However, since most bariatric surgical patients have a midline abdominal incision, it is better to develop the flaps as described by use of both vertical and horizontal incisions in order to produce the best result.

Exploratory Laparotomy

After the abdomen is carefully entered, all anterior abdominal wall adhesions are

divided. Some surgeons avoid exploring the abdomen and perform the procedure more superficially. Our preference to explore the abdomen is based upon the extremely attenuated anterior abdominal wall which some have termed “floppy” and “globally bulging.” Additionally, if the abdomen is not entered and all anterior abdominal wall adhesions divided, the patient is at risk of having an adhered loop of intestine plicated within the abdominal wall reconstruction, causing an intestinal obstruction.

Deep Lateral Flap Dissection

We prefer to perform the skin flap dissection just before closing the abdomen, in order to avoid accidentally dividing any closure suture with the electrocautery or other entity; also, earlier flap dissection may allow the flaps to “dry out” and become exposed to any intra-abdominal spillage which may occur. Therefore, before abdominal closure, the skin and associated fat mass are dissected from the underlying deep abdominal fascia out to the mid-axillary lines, above the costal margins and down to the inguinal regions, bilaterally and symmetrically. If the dissection leaves a thin layer of fat over some parts of the deep fascia, this has been acceptable, with no post-operative consequences. As we proceed more laterally, blunt dissection often helps speed up the process and locate the proper planes.

Care is taken around the anterior iliac crests to use as much blunt dissection as possible, in order to avoid injury to the lateral superficial cutaneous nerve of the thigh.

We usually dissect the umbilicus off the fascia together with the remainder of the flap and resect it with the other abdominal wall tissue mass. Like Davis,⁸ we recommend removing the umbilicus. Our rationale is that, since we regularly divide the deep blood supply to this structure at the time of dividing the ligamentum Teres with the initial bariatric operation, the umbilicus will be more ischemic than in patients who have not had the ligamentum transected. Therefore, it is at

risk of necrosis or, sepsis. Our “patient culture” is generally accepting of the omphalectomy. Sometimes, we have tried, with mixed success, to fashion a midline “dimple” about 16 cm caudad to the xiphoid.

Excising the Xiphisternum

The xiphoid may become rather prominent after massive weight loss causes it to emerge from beneath its fatty overcoating. In these instances, it is dissected out, keeping close onto the perichondrium in order to avoid arterial bleeding from the more proximal sternal area. After adequate dissection, the xiphoid is grasped with a Kocher clamp, and then trimmed or excised with Mayo scissors and/or electrocautery.

Abdominal Closure

After manually exploring the abdomen for any foreign bodies and ascertaining that all the counts are correct, the abdomen is sutured from pubis to the xiphisternum with continuous two-meter-long #2 Prolene sutures on T-50 needles, one from either end. Note that the inferior suture should start immediately above the pubis, not any higher. If a gap is left between the start of the fascial-imbricating suture and the pubis, a weakened area or suprapubic bulge may later become evident. It is also important to take care not to clamp, crush or otherwise injure the Prolene, which can thus be weakened and break easily.

We use a far-near, near-far imbricating suture technique, taking sufficiently lateral full thickness bites to produce an adequately strong and tight, but not too tight, closure. We invert all knots and, following every third suture passage, place, slightly more widely, a #5 Ethibond inverted, interrupted internal retention suture. Where a hernia is present, we place the #5 sutures one-for-one with the Prolene.

Before tying together the two Prolene sutures from either end of the wound, the tip of a right-angle clamp is passed under the more superficial Prolene loops, starting from

either end of the wound, and we serially traction upwards to draw out the excess suture. Often this produces several inches of additional suture length which we pull taut at the wound's center before instrument tying the two ends together with Broad Ligament clamps. We then tuck the knot and cut suture ends in through the fascia with a hemostat, so that they are not palpable through the skin.

It is an art form to widely and shallowly imbricate the abdominal wall to just the right width. Too wide an imbricating closure may cause an excessive increase in intra-abdominal pressure. This may, in turn, result in the viscera elevating the diaphragms, causing respiratory compromise. As a reasonably reliable guide to gauging the risk potential, the anesthesiologist measures the patient's peak inspiratory pressure (PIP) with the abdomen open and, again, after closure, at the same tidal volume (and same level of PEEP if used earlier). Normally, 4-5 cm water PIP increase has been acceptable which, with experience, has helped in determining a reasonably tolerable extent of abdominal wall imbrication.

Horizontal Incision and Final Deep Flap Dissection

Once the abdomen is closed, the lateral skin flaps are again addressed. In most patients other than those with a massive panniculus, the horizontal “spare tire” bulge ends not much more posteriorly than the mid to posterior axillary line. We confirm that our methylene blue, suprapubic, horizontal line has reached this point bilaterally, further extending the line as necessary. Then, we symmetrically incise along this methylene blue line through the skin and subcutaneous fat. We then dissect under each lateral flap, as needed to reach the lateral-most extent of the incision.

Tack the Horizontal Suprapubic Flap Upwards in the Midline

The horizontal incision results in a pro-

nounced skin and subcutaneous, non-undermined, flap edge across the lower abdomen. This flap's curved suprapubic midpoint is gently tractioned cranial. There, a 2-0 absorbable suture is passed through the fibrofatty mid-depth of the flap and the underlying midline abdominal wall fascia, and tied. If the suture is placed too superficially relative to the skin of the flap, the suprapubic skin will tend to lie at a deeper level relative to the lateral flaps when they are later advanced to it for approximation.

Marking Flaps Using “Cut to Fit”

Four Kocher clamps are placed strategically around the edge of one of the lateral skin flaps. With two assistants pulling on the clamps, the flap is placed on moderate traction contralaterally across the midline in an caudolateral direction. The surgeon, one hand palpating the midline incision beneath the flap, uses methylene blue to vertically mark the skin lying immediately above the midline for its entire length. Also, a horizontal line is drawn to mark the cranial-most palpated level of the suprapubic flap. A gentle convex-upward curve is drawn with methylene blue from the right angle intersection of these two lines to the lateralmost end of the horizontal incision. This line is adjusted as needed so that, under minimal tension, it can readily reach the inferior horizontal flap at all points. The horizontal and vertical lines intersect as a sharp right angle. Since a sharp-cornered flap end is less viable than a curved one, a reasonably gentle curve connecting the horizontal and vertical lines is drawn inside the sharp right angle. This completes the guide-line for fashioning the lower and lateral skin flap.

Earlier in our practice, we extended the vertical marking lines somewhat cranial to the upper end of the vertical scar through which the prior bariatric surgery had been performed. However, a slight “dog ear” sometimes remained after fashioning the flaps, so that we excised additional skin more cranially. This forced us to locate the upper end

of the abdominal incision well up onto the sternum between the breasts. To prevent this increased incision length and possible breast positional changes, each flap excision line was marked out inferolaterally from the uppermost end of the skin incision, to intersect with the previously-drawn methylene blue vertical line on the skin flap. This is done with the flap laid and gently held onto its approximate future location across the abdominal wall. The lines from the scar apex and the vertical one on the flap often need to be slightly re-drawn, so that both lines will proceed smoothly infero-latero-caudally.

The contralateral flap is then similarly marked. To minimize risk of contamination, while putting the second lateral flap on tension, it is best not to drag the undersurface of this flap over the skin of the contralateral flap. The lines are then again checked for flap symmetry and sufficient size before incising them.

Cutting the Flaps

Holding the knife blade with its upper edge slightly tilting inward away from the redundant skin mass, the marked skin is incised and the underlying tissue divided with an electrocautery, which is also used for hemostasis; parallel cut (“ladder”) tracks should be avoided. By this means, the cut edge of the lateral flap should have a better viability.

Meticulous Hemostasis

Postoperative bleeding rarely can be sufficiently serious for units of blood to be lost, and a return to the operating-room or sub-flap aspiration needed. Employing meticulous hemostatic technique with the electrocautery and, as required, suture-ligation, as well as the synechial sutures described below, oozing should be minimal or absent. Scar tissue from prior surgery in the region, such as cesarean-section, an earlier abdominoplasty or a giant panniculectomy, increases the risk of postoperative bleeding significantly. In these

cases, even greater hemostatic vigilance is urged. With massive weight loss, the deep fascial vessels penetrating into the pannicular tissue become denser due to the shrinkage of the fat depot. Additionally, larger vessels may be found rather superficially, and greater attention to hemostasis than usual is required. When in doubt concerning hemostasis, inserting closed (vacuum) drains is wise. Some use drains in all cases.⁵

Trimming Dog Ears

One or more of the three ends of the now T-shaped incision may have a dog-ear shaped corner. Even if it looks minor, it is wise to trim it because some patients regard it as a distraction and source of complaint. To remove “dog ears,” the apex of the redundant skin is elevated with a Kocher clamp, and Mayo scissors are positioned pointing longitudinally as an extension of the wound. With the scissors widely opened, the “dog ear” is excised. If it is too large to cut in one bite, we use the scissors marks on the skin and use methylene blue to draw an extension of them around the bulging skin to an apex where the skin is not elevated above its surroundings. This marked skin, and some of its associated, underlying subcutaneous tissue, are then sharply excised with a scalpel. Frequently, the place where the scissors commences its cut leaves a tiny unsightly irregularity of skin, which needs to be carefully trimmed down from each of the opposing skin edges. The skin is then approximated together with the remainder of the wound.

Synechial Suturing the Flaps

Each of the cut subcutaneous edges are serially advanced towards the midline, mildly rotating the large flap inferolaterally. This will allow a better match of skin length, i.e. the slightly more redundant suprapubic and more lateral cut skin edges usually have a more redundant length relative to the lateral flap’s caudal skin edge. In order to even these up, we

take advantage of the flap’s flexibility to rotate a greater amount of skin infero-caudally, in order to approximate to it. When rotating the flaps, it is important to assure that they are equally rotated to provide the best result.

Each slightly rotated flap is held in place by tacking it to the underlying abdominal wall fascia with simple, interrupted 2-0 Vicryl sutures, starting at the base of the flap about where the waist is located and placing more sutures at intervals outwards towards the flap edge. We then place parallel rows of similar sutures superiorly and inferiorly, to reduce dead space and chances of postoperative hemorrhage, thereby obviating the need for drains or continuous pressure dressing. This is essentially the synechial suture technique described by Mason.⁶

The lateral tension of the approximated midline skin can cause scar widening or even some skin separation. Therefore, we usually place interrupted inverted 0 Vicryl sutures through the subcutaneous fat and subcuticular layers as invisible retention-sutures to help take up much of the pull of the lateral flap. The skin of the vertical incision is then approximated with a continuous 2-0 Vicryl subcuticular suture. The subcutaneous fat is approximated in the horizontal incision as required, to close the dead space, and we then approximate the horizontal skin edges with wide skin-staples. The wound is dressed with 4x4 gauze, fluffs and a binder or wide orthopedic tape, which provides support for the abdomen and dressings.

OTHER PLASTIC SURGERY

Many patients also inquire about plastic surgery of the arms, thighs or breasts. Such procedures are considered by some to warrant the expertise of plastic surgeons.

Brachioplasty or Arm Lipectomy

Brachioplasty is the removal of excess skin

from the upper arms. While brachioplasty may be performed on those morbidly obese patients who have not lost weight, it is more commonly requested by those who have. The skin component is usually more extensive than the associated fat. This procedure is performed both for cosmesis and to improve function and hygiene. Excess skin of the upper arms can hinder a patient's range of motion, which can be very debilitating. Additionally, hygienic issues may pose a problem regarding skin infection and odor formation.

The procedure has one main drawback, that being the scars run the length of the upper arm. The skin of the upper arm is comparatively thin and delicate, and even thin and well-healed scars are very visible. However, this scarring is usually accepted by those undergoing the procedure, if their main goal is to improve function and eliminate odor. Those with purely cosmetic concerns accept the scars in exchange for the ability to wear sleeved clothes and be rid of the loose flapping skin of the upper arms.

Reduction Mammoplasty

Reduction mammoplasty or breast reduction is a commonly requested procedure by women with large, heavy, pendulous breasts, regardless of the size of the rest of their bodies. Complaints include back and neck pain, intertrigo in the infra-mammary fold, shoulder grooving from bra straps, inability to exercise, difficulty finding clothes that fit and self-consciousness from abnormally large breasts.

Breast reduction involves the removal of skin, subcutaneous tissue and breast tissue to reduce the size of the breasts. There are many different techniques to accomplish this goal.⁹ Some allow the nipple and areola to be transferred on a vascularized pedicle, while others transfer the nipple as a free graft. The different techniques affect the amount of sensation retained by the nipple postoperatively. The excision of breast tissue and skin generates scars, some more visible than others.

All the techniques have potential complica-

tions: loss of nipple sensation, loss of nipple tissue, wound infection or dehiscence, asymmetry and visible scars on the breast. The risk of these complications does not deter most women seeking a breast reduction. Even when a postoperative complication has arisen, most women, when asked, indicate that they do not regret having had the procedure. Breast reduction has a high acceptance rate in spite of the complications because in the majority of patients, this is not a cosmetic procedure but rather one undertaken to alleviate painful symptomatology. Immediately after surgery or within a few postoperative days, most women notice an improvement in the symptoms which led them to seek breast reduction. Many acknowledge complete resolution in the months following the operation.

For some women, the resolution of back and/or neck pain and the increase in the ability to bend and participate in athletic endeavors, initiates weight loss which reinforces their positive attitude about this procedure.

Those women in child-bearing years who are planning to become pregnant must be advised about the possible necessity of having the procedure repeated. However, this possibility should not be considered grounds for not having breast reduction.

Mastopexy

Mastopexy differs from reduction mammoplasty in that mastopexy primarily removes excess skin and subcutaneous tissue, while reduction mammoplasty removes breast tissue in addition to skin and subcutaneous tissue. While both procedures reduce the size of the breast, mastopexy does so merely by reducing the size of the skin and subcutaneous tissue envelope. Excision of breast tissue is not required.

Women seeking this procedure do not have the symptomatology of those women seeking breast reduction. Rather, the usual complaint is one of sagging, ptotic and unattractive breasts. Many of these women cite a substantial weight loss which precipitated the reduction in breast volume.

There are different techniques, depending on the severity of the breast ptosis. For some women, inserting an implant is all that is needed to fill out the skin envelope and alleviate the appearance of sagging breasts. This solution, however, is often short-lived, as the increased weight caused by the implant can worsen the skin laxity over time. Breast implant is usually not an option for the formerly obese patient. Another option is resection of skin and subcutaneous tissue, resulting in the reduction of the skin envelope; this procedure is beneficial for women who have enough breast tissue to fill the smaller envelope. For such women, a combination of the two procedures is needed. Those women need a reduction of the skin component, but do not have enough residual breast tissue to fill the newly created breast; here, an implant can give the breast a fuller, more normal appearance.

Complications of this procedure are similar to those of reduction mammoplasty. In addition, there are complications associated with implants: capsular contracture and implant rupture. The adverse effects thought by some to result from silicone implants have *not* been proven.

Lower Body Lift

Patients after successfully losing large amounts of weight may still have excessive skin of the lower body, due to loss of skin elasticity, being unable to return to its pre-obese form. This excess skin is often very distressing to the patient from a physical as well as mental standpoint. The loose excess skin can be debilitating functionally and hygienically. These patients can have the same problem of movement, range of motion and keeping themselves clean as they had before their weight loss.

The lower body lift, popularized by Lockwood,^{10,11} eliminates a portion of the excess lower body tissue while simultaneously re-suspending the remaining tissue, using the superficial fascial system of the skin for support. The superficial fascial system is

an extensive connective tissue network, connecting the skin and fat to the underlying musculoskeletal framework. Its primary function is to encase, support and shape the fat of the body. This operation allows for the smoothing of the buttock and upper thigh tissues to a greater or lesser extent, depending on the condition of the skin, the amount of weight loss and the amount of pull one places on the remaining tissues.

Although usually well-accepted by patients, this procedure is not without its associated risks and complications. These include seroma or hematoma formation, wound infection, wound dehiscence, loss of suspension, residual contour irregularities, and scarring from the extensive circumferential incisions required.

The lower body lift involves dissection to the superficial fascia layer of the skin of the hip and buttock area, interrupted dissection of the tissues of the hips and upper thighs using a specially designed Lockwood dissector, and pulling tissue superior decubitous to lateral decubitous (Figure 2). Aside from being time-consuming (4-5 hours on average) and requiring re-prepping and re-draping, there is a potential for uneven resection of tissues when both sides are done separately without the benefit of direct visual comparison (Figures 3, 4 and 5).

Because of the difficulty in performing this procedure correctly to avoid a poor result, the lower body lift is not often performed by the



FIGURE 2. Lockwood dissecting instrument.



FIGURE 3. Positioning and preparation for medial thigh lifting.



FIGURE 5. Left lateral positioning for lower body lift.



FIGURE 4. Right lateral positioning for lower body lift.

inexperienced surgeon. Depending on patient selection, when everything goes well, results can be dramatic.

Liposuction

One of the most important techniques in body contouring surgery is liposuction, as an adjunct or as a single treatment technique for truncal and extremity lipodystrophies.¹² Suction-assisted lipectomy is one of the most commonly performed cosmetic plastic surgery procedures. However, its use in the obesity patient is more limited due to the amount of excess skin that is often encountered. Liposuction, however, can be an important adjunct to the abdominoplasty portion of a body contouring procedure and

can provide final symmetry in extremity procedures.

The history of modern liposuction dates to 1978, when Illouz first used blunt cannulas, sparing structures between muscle fascia and skin to remove excess adipose tissue.^{13,14} In 1988, Zocchi described the use of ultrasonic energy with liposuction cannulas for more efficient fat removal.¹⁵ Another important concept in the history of liposuction was a description and use of wetting solutions to facilitate fat removal. Illouz was the first to use subcutaneous infiltration and he used hypotonic saline for what he termed *lipolysis*.¹⁴ Fodor expanded the concept of wetting subcutaneous infiltration and developed what he termed a *superwet* technique.¹⁶ Klein was the first to use the term *tumescent technique* as a key component for suction-assisted lipectomy.¹⁷ Table 4 illustrates the terminology currently describing subcutaneous infiltration. Table 5 outlines the current wetting solution formula used by the authors in both local and general anesthesia procedures.

Equipment: Advances have occurred in the development of liposuction equipment. Cannula development has gone from larger diameter cannulas to much smaller cannulas that have non-cutting tips and guides to illustrate the opening position. Aspiration equipment includes both suction pump machines and syringe aspiration. Both of these generate

TABLE 4. SUBCUTANEOUS INFILTRATION SOLUTION TERMINOLOGY

• Dry	• No Infiltrate
• Wet	• 200-300 ml/area
• Superwet	• 1:1 infiltrate/aspirate
• Tumescence	• 2-3 ml infiltrate per ml aspirate—“skin turgor”

TABLE 5. WETTING SOLUTION FOR GENERAL ANESTHESIA

1 L Ringer’s Lactate	50 ml 0.5% or 1% Lidocaine
1 ml 1:1000 Epinephrine	*warmed to 38° C (if no ultrasound) *use of 0.5% in larger volume cases

similar pressures, approaching 760 mmHg. The use of the syringe technique, however, does add longer operating-time.

Patient Evaluation: Patient evaluation is extremely important in obtaining good results with liposuction. Patient evaluation centers around both a medical and psychological history, as well as a physical examination with particular attention to evaluation of the skin, previous scars, striae, cellulite, skin ptosis or excess, and regional differences, before deciding whether liposuction is an acceptable single modality or an adjunctive procedure in skin resection. Once a decision is made to use liposuction as a technique for body contouring surgery, consideration regarding anesthesia and technical aspects must be appreciated to achieve acceptable esthetic results. Anesthesia can be done under straight local or with IV sedation, or by general anesthesia. The tumescent technique described by Klein provides adequate anesthesia for local aspiration.¹⁷ Lidocaine toxicity, however, must be considered and the amount of lidocaine that is used is proportional to the percent added into the wetting solution and the volume of wetting solu-

tion that is infused before aspiration. Table 6 outlines volumes necessary for lidocaine toxicity using both a 35 mg/kg and 50 mg/kg limit. One needs to be aware that lidocaine toxicity can be a delayed event due to peak lidocaine plasma levels occurring approximately 12 hours after infusion. Illousz described *ten commandments of adipoaspiration* that provide the surgeon excellent technical guidelines:¹⁴

- 1) Create only tunnels
- 2) Be as gentle as possible.
- 3) Respect the superficial layer of fat.
- 4) It is not so much what is removed, but what is left behind.
- 5) Use, anticipate and estimate skin retraction.
- 6) Do not over correct.
- 7) Indication should be restrictive.
- 8) All fat resection is final.
- 9) Results in the operating-room approximate final outcome.
- 10) Technique depends on the blind surgery.

When one considers these ten commandments, it is evident that the complexity of liposuction is much greater than apparent. It must be stressed that the most important criteria for a successful outcome in liposuction surgery is patient selection.

Complications: Complications of liposuction range from contour deformities to intraoperative and postoperative death.¹⁸ Intra-abdominal perforation is a rare complication, but has been reported as a cause of death. This devastating complication can be avoided by starting at the preoperative examination with looking for any abdominal hernia. The use of short

TABLE 6. VOLUMES NECESSARY FOR LIDOCAINE TOXICITY

Weight	35 mg/kg	50 mg/kg
50 kg	3.5L	5L
60 kg	4.2L	6L
70 kg	4.9L	7L
80 kg	5.6L	8L
90 kg	6.3L	9L
100 kg	7.0L	10L

blunt cannulas also decreases the chance of intraabdominal perforation as well as guidance of cannulas with the non-dominant hand. Adequate subcutaneous infiltration also allows for easier passage of the cannulas.

Another reported cause of death in the liposuction patient is from lidocaine toxicity. As stated above, this must be considered when one calculates amount and concentrations of the subcutaneous infiltration solution, due to blood levels reaching their peak approximately 12 hours postoperatively. This complication has frequently been reported by the inexperienced surgeon; it can be avoided by careful recording of the volumes and concentrations of infusion. Knowledge of the signs of lidocaine toxicity as well as lower dose considerations for certain patients with a history of liver disease or oral contraceptive use are important. The early signs of lidocaine toxicity include drowsiness and anxiety, with the late signs being convulsions, coma and respiratory depression.

With the advent of superwet and tumescent technique of infusion, pulmonary edema as a complication must be considered by both the surgeon and anesthesiologist. It is important for the surgeon to communicate with the anesthesiologist as to the amount of infusion given as well as the anticipated amount of aspiration. Table 7 illustrates a ratio of subcutaneous fluid infusion to the anticipated total aspiration that the authors use as a guideline in their patient population.¹⁹ Careful monitoring of fluid status in large volume cases requires the use of a urinary Foley catheter. Caution must be used in the elderly or any patient with a history of lung disease.

Infection is a devastating, but fortunately very rare, complication of liposuction. Prophylactic antibiotics are used and sterile technique is maintained throughout the procedure. There are reported deaths from infection and necrotizing fasciitis.

Hemorrhagic shock is an unusual complication, particularly with the advent of superwet

TABLE 7. RATIO OF SUBCUTANEOUS FLUID TO TOTAL ASPIRATE

<i>Total Aspirate</i>	<i>Fluid/Aspirate Ratio</i>
0-1,499 ml	2-3:1
1,500-2,999 ml	2:1
3,000-5,999 ml	1.5:1
6,000-9,999 ml	1.4:1

techniques. This should be considered as a possibility, particularly when multiple body contouring procedures are being performed. In large-volume liposuction cases associated with skin-resection body-contouring procedures, preoperative autologous blood donation is required.

Another complication reported is deep venous thrombosis. This complication can be reduced but not completely avoided in a large series of patients. Patients on oral contraceptives or who have longer operating-times are at higher risk for venous thrombosis.

Fat emboli syndrome has also been reported. Its signs and symptoms include confusion, dyspnea and petechiae. The syndrome causes ischemic changes in the pulmonary and cerebral circulation. Fat emboli syndrome can be avoided by preventing hypovolemia. There are some studies to suggest that steroids in the preoperative period may have some benefit in reducing this complication. Drains can provide an egress of fat particles. Alcohol infusion and heparin may be of some value in the prevention of this syndrome. Treatment of this syndrome includes oxygen and fluid resuscitation.

Esthetic complications include contour irregularities that may present as waves or ripples in the overlying skin or depressions particularly in the extremities. Asymmetry is also of concern. The contour deformities and asymmetries can be avoided by using smaller cannulas and keeping the plane of dissection in the deep fat. The non-dominant hand is particularly important in feeling the treated areas as the cannula is passed through the underlying fat, to help judge final contour and stop points.

Postoperative Care: Patients are encouraged to ambulate early in the postoperative period. Compression binder garments are used as well as topical foam, which provide patient comfort, reduce ecchymosis in the treated areas, and decrease early postoperative edema. Drains play an important part particularly in the use of the ultrasonic energy due to the high likelihood of seroma formation in these patients. Pain management consists of a mild oral analgesic.

Summary: Liposuction has been a major advance for body contouring. It is a safe and reliable technique that when applied to the right patient population, achieves consistently good results. Liposuction can be combined with other procedures; however, good surgical judgement and patient evaluation are important. It is necessary to discuss with the patients that certain complications may be more likely in a combined procedure versus two procedures. If one anticipates the potential complications, they can be avoided or kept to a minimum; however, should any complications occur, their early recognition and effective treatment will most likely not affect a positive outcome for the patient.

CONCLUSION

The plastic surgeon faces many challenges, but none more rewarding and at the same time more difficult than treating the obese or formerly obese patient. This patient may present with cosmetic, functional, hygienic or a combination of these concerns. Obese patients have excess skin and subcutaneous fat. While this presents a cosmetic issue, it frequently inhibits the patient's ability to perform many tasks of everyday life which most of us take for granted.

Excess tissue can interfere with the performance of adequate hygiene, predisposing the patient to skin disease which may ultimately result in skin breakdown and non-healing

wounds. Inability to maintain adequate hygiene may be due to limited range of motion of the arms secondary to large size, inability to lift a huge pannus, or to reach all areas of such a pannus secondary to the discrepancy between pannus size and arm length. Achieved cleanliness is often short-lived. Skin to skin contact in folds results in a warm moist environment, due to body heat, environmental factors and friction. This creates an environment for bacterial and fungal growth, leading to skin and odor problems. These odors often lead to the misconception that obese individuals are slovenly and do not care about personal hygiene.

The weight and dimensions of excess tissue, especially in the abdominal area, can impede ambulation. The pannus of an obese individual can hang down to the knees, making walking difficult. This immobility may set the stage for additional weight gain.

Even when obese persons lose significant amounts of weight, usually through bariatric surgery, their problems may not be resolved.²⁰ Excess skin and subcutaneous tissue caused by longstanding morbid obesity may result in loss of elasticity so that the area is unable to resume its original contour. After massive weight loss, loose, hanging stretched skin can be just as problematic as when it was filled with subcutaneous fat. This can have a major psychological impact on patients, who seek plastic surgery to attain the desired benefits of their weight loss.

While concerns in obese and formerly obese patients may involve the face and neck, these are less common and have not been discussed here. The most commonly performed procedures in these patients are panniculectomy, liposuction, abdominoplasty, brachioplasty, reduction mammoplasty, mastopexy and lower body lift. Each procedure has specific indications and may not be right for every patient. Also, although these procedures may improve the patient's quality of life, they are by no means a panacea. However, even with associated morbidity, these procedures are well accepted by the majority of patients.

Panniculectomy differs from the more familiar and commonplace abdominoplasty, in that abdominoplasty is for those without a component of functional impairment and is considered a cosmetic procedure. Abdominoplasty is used for the removal of a minimal to moderate amount of abdominal skin and subcutaneous fat, with undermining of the skin to allow for the smoothing of the entire abdomen from xyphoid to pubis. In this procedure, the navel is preserved and the muscle fascia is plicated to contour the waist and hips.

In contrast, panniculectomy is performed to remove a massive pannus, which has frequently contributed to a functional deficit as well as hygiene problems. This is not a cosmetic procedure and may be considered an amputation of tissue. The umbilicus is not preserved, there is no undermining of the abdominal flap and no fascial plication. The goal of panniculectomy is not to create a smooth flat abdomen, but rather to remove excess pannus to give the patient an increased functional level.

Panniculectomy, however, is not without associated morbidities. Wound dehiscence, seroma or hematoma formation and wound infection are common problems. Multiple drains are routinely placed during closure, but these drains have been known to clot and also be pulled prematurely by the patient, sometimes purposefully but most times unintentionally.

Infection can be a big problem. Many morbidly obese patients have associated medical problems, especially type 2 diabetes, and wound healing problems are common. Additionally, fatty tissue not excised can be devitalized, leading to fat necrosis and subsequent infection. These postoperative complications can be reduced with preoperative antibiotics, good surgical technique and close attention to wound care. In addition, patients may have increased morbidity from surgery and anesthesia in the form of pulmonary problems, atelectasis, deep venous thrombosis and pulmonary embolus. However, plastic surgery in these patients usually significantly improves quality of life and in some instances

may be an impetus towards increased activity and continued weight loss.

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