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Research Article

The Art and Science beyond Body Contouring A Solution for Massive Weight Loss Patients

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Abstract

The massive weight loss often resulted in an excess of loose skin mainly in the abdomen, upper arms, thighs, chest, back, and laterally on the back. Consequently, most patients sought for a solution, provided by the plastic surgery through the body-contouring surgery. Abdominoplasty, arm lift, tight lift, breast lift, and liposuction are all body contouring procedures that aim to reshape the patients' body. Furthermore, body-contouring surgery can improve the patients' physical discomfort in daily life, also helping in the maintenance of normal BMI (body mass index) in formerly obese patients, thus having a positive aesthetic and psychosocial outcome. A key component of body contouring after massive weight loss is managing patient expectations. Understanding the risks of body contouring's procedures is important for patient counseling and the informed consent process.

The goal of this study was to perform a literature review concerning the indication, surgical technique, outcomes and complications of body-contouring surgery.

Keywords

Body-contouring surgery; Abdominoplasty; Brachioplasty; Liposuction; Thighplasty

Introduction

In 1991 the World Health Organization (WHO) classified overweight as Body Mass Index (BMI) exceeding or equal to 25, while obesity as BMI over or equal to 30 [1]. During the last decades, obesity became an epidemic condition in all the Occidental countries. Just to turn it into numbers: worldwide 1.4 billion people were recognized as overweight in 2008, of these 500 million were obese [1]. In the UK 26.7% of adult population is obese, and this rate rise up to 36.7% in the USA [1].

Bariatric surgery was the answer given to the need to look for a solution, and given to its reliability and effectiveness, the number of bariatric procedures gradually increased from 16,200 in 1992 to 220,000 in 2009 [2]. Indeed bariatric surgery can achieve a lasting weight loss ranging from 47.5% to 70.1% depending on the procedure performed [2]. Furthermore it can reduce the prevalence of severe risk factors (i.e., diabetes, hypertriglyceridemia, hyper- uricaemia) resulting in a decrease of the total mortality [3].

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Nevertheless massive weight loss often resulted in an excess of loose skin mainly in the abdomen, upper arms, thighs, chest, back, and laterally on the back [4]. Consequently most patients sought for a solution, provided by the plastic surgery through the body-contouring surgery. Abdominoplasty, arm lift, tight lift, breast lift, and liposuction are all body contouring procedures that aim to reshape the patients' body [5].

Commonly, once a patient has achieved the desired BMI, 6 months of stable body weight need to pass prior to that he/she can apply for a body-contouring procedure [5]. Indeed it was demonstrated that the effect of surgical lipectomy on the body-weight it's only transient and tent to fade within a few month as a consequence of fat redistribution and compensatory fat growth [2]. However body-contouring surgery can improve the patients' physical discomfort in daily life, also helping in the maintenance of normal BMI in formerly obese patients, thus having a positive aesthetic and psychosocial outcome [6,7].

Given these evidences, the number of body-contouring procedures keeps growing year by year [8]. In USA alone, more than 450,000 body-contouring procedures were performed in 2016, of which 55,000 were secondary to massive weight loss [8]. Nevertheless only 6% to 20% bariatric procedure are followed by secondary body-contouring [8]. Furthermore it is reported in literature a 60-87% increased risk of complications in patients undergoing cosmetic body-contouring procedure following bariatric surgery [8].

Given the demand for post-bariatric procedures along with the increasing bariatric surgeries performed, the present literature review aims at providing the reader with the latest trend in body-contouring, analyzing the area that are most often treated during our practice, highlighting: indication, techniques, complications, and outcomes.

Abdominoplasty

Abdominoplasty or tummy tuck is the body-contouring procedure that aims to remove the exceeding abdominal skin and subcutaneous tissue in order to improve the aesthetical appearance and eventually reconstruct the structure of the abdominal musculoaponeurotic layer [i.e., abdominal recuts muscle diastasis (ARD), abdominal hernia (AH)] [9].

Thus the cosmetic outcome should result in the growth of the patient's self-esteem, while the patient's functional status would improve as well.

Abdominoplasty is the 2nd most performed body-contouring procedure, following only liposuction. In USA 128,000 tummy tucks were performed in 2016, 24,000 of which were post-bariatric procedures [8].

The first report of dermo-lipectomy dates back in 1890 with Demars and Mark [10], but it was only in 1899 with Kelly [11], that the abdominoplasty was conceived like today as the procedure to remove the excess of skin and fat in order to give a more aesthetically pleasant appearance to the abdominal wall. During the nineteenth century, numerous variation and modifications of abdominoplasties were described the various authors.

Gaudent and Morestin [12], were the first to use a large transverse incision for the correction of abdominal wall hernia in conjunction with a dermo-lipectomy, while Frist [13], was the first to reposition the navel into its anatomical position. In the 1980s the introduction of liposuction into the routine clinical practice dramatically improved the body sculpturing capabilities of tummy tuck. Psillakis [14], introduced the suture plication of musculoaponeurotic layer, Hakme [15], first suggested the mini-abdominoplasty, and Lockwook [16], described the high-tension abdominoplasty. However most of the attention of the authors was directed toward the research of the best way to place the skin in order to obtain the optimal combination of scar camouflage and cosmetic outcome.

Indication: Abdominoplasty can address many deformities of the abdominal wall as consequence of significant weight loss following pregnancy and bariatric surgery, abdominal wall alteration/flaccidity, localized lipodystrophy, and post-operative complications (scars, ARD, AH) [17].

Functional (limitation in daily life, postural alteration, back pain, recurrent intertrigo/infections in the skin folds) and aesthetic (unpleasant shape, physical disproportion, disability to wear fitted garments) are the reasons which can make a patient suitable for an abdominoplasty. Men and women can both undergo a tummy tuck with good cosmetic/functional outcome.

The careful diagnosis of the abdominal contour deformities allows the surgeon to choose the most appropriate approach for each patient. Indeed the various techniques described address differently skin/subcutaneous fat accumulation based on their patter distribution.

In order to better correlate the type of deformities to the appropriate surgical management, various system of classification was described [18]. The "Pittsburgh Rating Scale" introduced by Song et al., [18]. was specifically designed for massive-weight-loss patients; hence it could be adopted as a guideline for preoperative planning and postoperative outcome analysis.

History and physical examination are also of paramount importance in guiding the surgical planning. Previous surgeries or pregnancy, desire for future pregnancy, scars, history of liposuction, intra-abdominal content/pressure, quality of skin, physical condition, cigarette consumption, and patient's request must all be carefully evaluated prior to surgery in order to individualize the treatment [10].

Since body-contouring surgery is not a life-saving procedure, a careful evaluation of the medical co-morbidities and nutritional status is mandatory (especially for post-bariatric patients) [19].

Technique: As previously said the goals of the abdominoplasty are to excise the overhanging skin/subcutaneous tissue and eventually repair the associated ARD/AH with the minimal scarring. Thus the different techniques differ mostly in the scar positioning, commonly placed above the pubic area in order to be easily hidden underneath the underwear or beach attires. Nevertheless the lower incision line should be never closer than 6-7 cm to the anterior vulvar commissure. Furthermore different incisions gave various degree of access to abdominal wall defects.

Once the planned skin incision has reached the underling Scarpa fascia, dissection is taken through this plane below the level of the arcuate line, and then it is deepened to the musculoaponeurotic layer until the costal margin is reached. Nowadays, undermining the abdominal flap is far less extensive than in the past and is performed only along a central tunnel above the navel not to jeopardize the blood perfusion coming from the intercostal vessels. Muscle plication or AH repair can then be performed. Closure of ARD is commonly performed using interrupted 0 braided non-absorbable sutures, positioned in "X" shape in order to strengthen the musculoaponeurotic layer along the linea alba from the xiphoid process till the pubis, bringing the rectus muscle together along the midline. This step can be followed by two running 0 braided non-absorbable sutures both starting from the navel, one directed toward the xiphoid process, the other toward the pubis. Oblique plication can also be performed with two ascending sutures on each side of the navel having an inward and downward direction. As a result, the ARD, protrusion or vertical laxity will be corrected, furthermore the waistline will be reduced. Nevertheless some patients may still present abdominal wall deformities in the standing position. Thus, having the patient seated at 90° on the operating table any remaining weak area of the abdominal wall can be localized. Whenever the deformity is present, the line of maximum protrusion is identified; the patient is brought in supine position, and 1 to 3 horizontal mattress sutures are placed along this line at each side. This maneuver is then repeated so any further epigastric laxity or bulge can be identified [20]. While performing the muscle plication, the anesthesiology has to check for respiratory function impairment consequent to the increased intra-abdominal pressure.

Resection of the exceeding skin/subcutaneous tissue must be carefully evaluated in order to remove it as much as possible but without resulting in extreme wound closure tension. Both the lower and superior skin incision should be beveled at 45° for precise layers apposition.

Whenever the navel needs to be transposed, it is preserved in position during abdominal flap undermining, and eventually secured to the recuts sheath prior to being repositioned back in place. The final location of the navel can be determined by means of Pitanguy type flap demarcator, or Lockwood marker, or even measurement of the umbilicopubic distance.

Now one suction-drain at each side can be positioned prior to wound closure that has to be performed in layer (Scarpa fascia, subdermal layer) with the use of slow absorbable either interrupted braided or running barbed sutures, having the patient flexed 30° degrees. Wound closure can be completed with an intracuticolar abdosbable monofilament running suture. Precise approximation and extreme wound eversion must be achieved for optimal scarring.

An elastic compressing garment is applied prior to the patient's awakening and should be worn from 30 to 60 day, keeping it the first period day and night.

Currently, abdominoplasty may be associated to liposuction in order to achieve the best cosmetic outcome possible in what it is called "lipoabdominoplasty". Liposuction is performed at the time of the abdominoplasty and is more aggressive at the level of the un-detached abdominal flap. This will result in further tightening while reducing the risk associated with extensive undermining.

Massive-weight-loss patients have a different surgical approach. Indeed the procedure is no more defined as abdominoplasty, which is an aesthetic surgery, but panniculectomy, that is a primarily functional/reconstructive procedure. The excess of skin and subcutaneous tissue is present also laterally and/or circumferentially, and should be addressed during the same operative session whenever

possible. As a result the lower abdominal incision is taken further laterally; nevertheless large lateral dog-ears may form laterally and should be addressed with a second surgery. The undermining of the abdominal flap should be even further less extensive than during an abdominoplasty in order to preserve as much as possible the blood supply. For the same reason, a concomitant liposuction is generally not advisable. The muscle plication should be limited since the intra-abdominal pressure usually does not allow pushing it too far.

- Mini-abdominioplasty: it's a short-transverse scar abdominoplasty that is commonly completed by a liposuction. It's indicated with mild to moderated skin laxity of the lower abdomen below the navel. When muscle plication or AH repair of the epigrastric region is required, it has to be performed endoscopically. The lower incision line must respect be at least at 6-7 cm from the pubis, while the superior one should be at ≥ 9 cm from the navel. Its lateral extent should be as limited as possible but enough to deal with the lower abdomen fat depot and prevent the formation of dog-ears. Abdominal flap undermining is limited to the lower abdominal flap below the navel level, which does not need to be repositioned.
- Modern abdominoplasty with umbilical transection: it broadened the indication of the mini-abdominoplasty to those patients with looseness in the periumbilical area. The umbilical-pubic distance should be ≥ 14-18 cm since the navel is transposed downward by being transected and secured back to the fascia into the new position. Surgical procedure and line incision placement follow the same principle of the mini-abdomnioplasty. When resecting the abdominal flap excess, it must be kept in mind the 60-40 ratio between the abdomen above and below the navel.
- Standard abdominoplasty: it's the most used tummy tuck technique worldwide. It allows dealing with most of the abdominal deformities, removing the exceeding abdominal skin flap, and ensuring proper exposure of the musculoaponeurotic layer for ARD/AH repairs. The lower skin incision is placed at a 7-cm distance from the lower border of the pubic symphysis extending for 7 cm bilaterally from the midline, parallel to the abdominal skin fold. Then the incision line is usually directed upward at variable angle degree depending on the age and fashion style of the patient. Usually without overpassing the superior anterior iliac spines neither superiorly nor laterally. Abdominal skin flap undermining is performed in a bell-shape fashion, having the larger area of dissection below the navel, and tunnel-like above it. The umbilicus is transposed without transecting it, thus patients must be aware of the circumferential umbilical scar. The surgery is usually completed with a liposuction of the superior abdominal region and the un-undermined areas (Figures 1 and 2).
- High-lateral-tension abdominoplasty: it broadened the indication of the standard abdominoplasty to massive weight loss patient who present with flank/lateral laxity. The main markings and surgical procedure are similar to the standard abdominoplasty, furthermore intermitted lateral undermining is performed and dead space is obliterated with the use of dermal-fascia suture placed in a downward inward direction resulting in a "V" shape. It allows wider lateral excision along with a more conservative central resection.
- Fleur-de-lis (anchor-line) abdominoplasty: this technique ensures the maximum improvement of body shape and reduction of waist circumference. It can eliminate both vertical and horizontal skin excess. Its name derives from the shape of the dermolipectomy, having the exceeding skin/subcutaneous tissue removed en bloc from the lower abdominal quadrant and median/paramedian area. The resulting scar is an inverted "T" that can extend vertically from the pubis to the xiphoid process; thus it has to be discussed with the patient prior to surgery. Again lateral intermitted flap mobilization can be performed cautiously and limited as possible not to harness the vascularization of the flaps.
- Vertical abdominoplasty: it has very limited indication to patients that have a pre-existing xiphoid-pubic scar with the need for abdominal contour improvement only. It implies a vertical incision resulting in a xiphoid-pubic vertical scar; however it gives access to ARD/AH repair.

Complications and outcomes: Given the different abdominoplasty procedure available in the armamentarium of plastic surgeons, patients' satisfaction after tummy tuck is fairly high [21]. Furthermore it improves greatly the self-esteem and quality of life, especially after bariatric surgery. This result is increasingly being accepted as the primarily end-point in these patients [21]. The

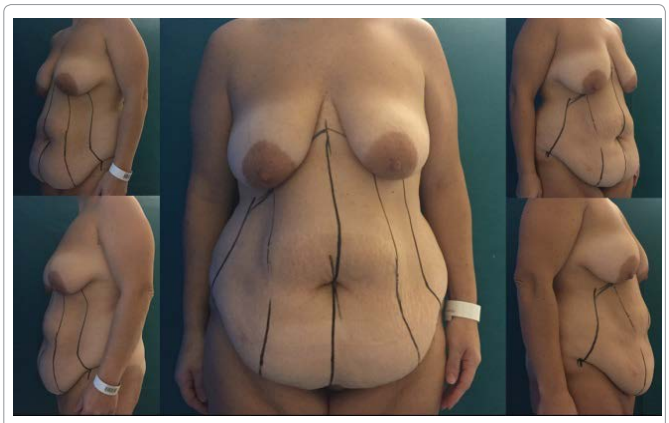

Figure 1: Pre-abdominoplasty. A 40 years old woman with an excess of loose abdominal skin after losing 50 kg due to bariatric surgery. The weight was stable for more than six months.

Figure 2: Post-abdominoplasty. The same woman of Figure1, without excess of loose abdominal skin after abdominoplasty.

Multidimensional Body-Self Relations Questionnaire and the Body Areas Satisfaction Scale developed by Bolton et al. [22], as well as the body image assessment designed by Williamson et al [23]. are tools that were used to evaluate the quality of life and satisfaction of their overall appearance following post-bariatric surgery.

Despite contradictory studies present in literature, most authors accordingly agree in the beneficial effect of post-bariatric abdominoplasty, improving the patients' functional status too [7,23]. Finally patients satisfied with their reshaped abdominal contour tend to maintain for longer lower body weight than those that didn't receive post-bariatric cosmetic procedures [24].

Abdominoplasty is a safe and effective surgery that can reshape the abdominal area and correct/reinforce the muscoloaponeurotic layer. Nevertheless it can be affected by a number of complications that can be divided into medical and surgical once. Medical complications are the most severe and less frequent ones, namely deep venous thrombosis – pulmonary embolism, systemic infections, and pulmonary function impairment due to increased intra-abdominal pressure [25]. All these condition must be promptly recognized and treated since these are life threatening.

Surgical complications are more frequent and can be further divided into minor (6.3 %) and major (6.8%) ones depending on the need for surgical revision [26].

Hematoma, seroma, wound infection/dehiscence, fat necrosis; parenthesis and persisting numbness are the main one [4]. Seroma formation is the most common and serious problem because, when persistent, it may require a revision surgery [27]. Furthermore it may also get infected, resulting in localized, local hyperthermia, fever and eventually systemically ill. Prompt surgical drainage and antibiotics administration is mandatory. The preservation of the Scarpa fascia helps preventing seroma formation. Indeed it was demonstrated that when the Scarpa fascia of the infraumbilical area is preserved: the drain output is reduced by 65.5%, the suction drains can be safely removed earlier while eliminating longer than 6-day maintenance periods, and seroma formation rate is reduced by 86.7% [28]. Thus Scarpa fascia preservation is particularly indicated in patients at high risk of seroma formation: men, obese patients, and patients with massive weight loss [29].

Minor wound dehiscence usually occurs but commonly it doesn't require any treatment. Whereas significant dehiscence may occur to both central andzScar asymmetry, hypertrophic scarring, umbilical malposition, elevation of the pubic area, painful neuromas, and dog-ears are the most common late complication that require revision surgery based on patients will [30].

In their work, Fisher et al. [26], revealed that underlying comorbid conditions, decreased nutritional status, and bleeding disorder were associated with increased odds of minor wound complications; whereas decreased functional status was the only independent predictor of major surgical complications.

Furthermore pre-operative BMI is one of the main risk factor for major postoperative complications regardless of whether the patient underwent previous bariatric surgery [31].

Brachioplasty

Brachioplasty is one of the most rapidly growing procedures in body contouring. Indeed the newly aesthetic importance given by modern fashion and culture to fit arms brought the number of brachioplasty to rise 807.4% from 1997 to 2014 [32]. In USA alone 17,900 upper arm lift were performed in 2016; 6,900 of which were post-bariatric procedures [8].

Correa-Iturraspe and Fernandez [33]. were the first that described an aesthetic brachioplasty in 1954. Their work was followed only 20 year later by Pitanguy [34]. which improved the technique in order to reach "tension-free" closure for acceptable scarring.

Then Glanz and Gonzalez-Ulloa [35]. were the first to describe quantitatively the aging process of the upper arm by using radiographs to measure the ratio of soft tissue superior and inferior to the humerus in the upper arm at the midhumeral line. The resulting ratio was called the "Hoyer coefficient" and was the first classification system for brachial laxity.

Indication: Significant upper-arm skin laxity secondary to weight loss, lipodystrophy, aging, or post-bariatric weight loss is the main indication to undergo a brachioplasty [36]. Indeed the exceeding skin in the inner upper-arm can be perceived as unsightly and may interfere with patient's comfort and dressing habits. A wide range of preoperative markings, incisions, flap design, and closure techniques are described in literature. The introduction of liposuction during upper-arm lift greatly improved the cosmetic outcome, allowing smaller, bloodless, and less-invasive surgical procedure with much better resulting scars [37].

The use of the pinch test can help choosing the best candidate and area that would benefit the most from a liposuction. Younger patients, with good quality elastic skin, and mild inner upper-arm deformities, are best suited for a simple liposuction, which can ensure good scar-less cosmetic outcome. Whereas, older, post-bariatric patients, with moderate-to-severe skin laxity would have their deformity even worsened if a simply liposuction is performed. Thus wide skin/subcutaneous tissue removal should be performed to these patients. Finally a limited-incision brachioplasty technique was described for patients that stand between these two clinical conditions [38]. This mini-brachioplasty in conjunction with a liposuction can indeed address with tremendous cosmetic outcome the proximal third upper-arm and axillary deformities.

Again, various deformities classification systems were described in the attempt to better correlate the type of contouring alteration to the appropriate surgical management [39]. The classification system developed in 1998 by Teimourian and Malekzadeh divided the patients into four group based on the grade of lipodystrophy and estimated amount of skin laxity [39].

Whereas in 2006, El Kahtib [40], evaluated the distance from the brachial sulcus to the lowermost border of the skin excess as to grade the brachial ptosis and relate it to the preferred surgical management.

Technique: As previously mentioned, diverse surgical techniques were described which differ mainly in marking, scar positioning, and extension to the axillary fold. All of them provide the dermolipectomy of the exceeding skin, which can be identified with a pinch test having the patient with the arm abducted and the elbow in supine position. Liposuction is usually performed prior to the dermolipectomy in order to reduce the volume of the deformities with minor risk of damaging vessels, nerves, and lymphatics [41]. Liposuction is taken underneath the area of skin excision as well as at its anterior, posterior, and lateral edges.

Excision is limited to the skin and very superficial subcutaneous tissue as not to damage any important structure. Undermining is not

necessary since tissues are very mobile, and proper pre-operative planning ensures the removal of the right aliquot of tissue. Whenever in doubt, the intraoperative staple technique can help the surgeon in this tailor-tacking step [42]. Wound closure is performed in two layers with the use of slow absorbable either interrupted braided or running barbed sutures, and completed with an intracuticolar abdosbable monofilament running suture. Again precise approximation and extreme wound eversion must be achieved for optimal scarring. Suction drains are usually not required.

The need for a Z-plasty in the axilla must be assessed in the preoperative period and is always suggested in case of massive weight loss patients. Nevertheless scar contraction rate is very low. The best way to choose where to place the Z-plasty is to pull the scar distally searching for the area of maximum tension [41].

An elastic compressing garment is used prior to the patient's awakening and should be worn from 3 to 5 weeks.

- Minimal incision brachioplasty: as previously stated, this procedure is indicated for younger patients, with good quality elastic skin, and mild inner upper-arm deformities. It can address only the excess of skin in length, not in width [42]. The horizontally placed skin incision will result in an unsightly scar in the axillary fold at the proximal end of the upper arm.
- Standard brachioplasty: this technique is indicated when a patient has an excess of skin limited to the proximal $^{2}/_{3}$ of the upper arm. First the future suture line is marked on the arm, and should be best place at the junction between the upper $^{2}/_{3}$ and lower $^{1}/_{3}$, while it should be 2 cm longer than the deformity to excise. An ellipse can now be drawn determining the superior and inferior incision lines by downward and upward traction. A small triangle of axillary resection can be added (Figure 3).
- Extensive brachioplasty: This technique is indicated in case of extreme weight loss and the excess of skin spans along the entire upper arm till the superior epicondyle area. Furthermore axillary and antero-lateral chest wall skin laxity usually has to be addressed too. The marking are similar to those of the standard brachioplasty. The distal end of the incision line is taken till the medial epicondyle; whereas the proximal one can reach the distal portion of the axilla on the lateral chest wall.
- Fish-incision brachioplasty: [43]. patients presenting with large "bat-wing" shaped skin excess extending from the olecranon process to the axillary fold without additional laxity on the thorax are best suited for this procedure. The skin excision ellipse is designed likewise the standard brachioplasty, however, once reaching the axillary fold it widens in a fish-tale shape ending at the level of a line joining the lateral border of the pectoralis major with the anterior border of the latissimus dorsii muscle.

Complications and Outcomes: The continuous rise in demand for brachioplasty in plastic surgery practice indicates the growing interest that patients have in their shape, probably following the evolution of fashion. Numerous procedures have been designed in time so that the surgery can be individualized to the patient and his/her problem. Like all body-contouring procedures, brachioplasty improves greatly the self-esteem and quality of life of patients, especially after bariatric surgery, thus having rate satisfaction fairly high too [21].

Complication following brachioplasty can be divided in minor (seromas, hypertrophic scarring, cellulitis, wound dehiscence, subcutaneous abscess) and major one (nerve damage) [44]. Minor complications tents to be auto-limiting and conservative treatment with no secondary surgery are often the best strategy.

Knoetgen [45], reported on a retrospective study no complications in 40 patients who underwent simultaneous liposuction and brachioplasty. Le Louarn [41], conducted a similar study on 21 patients undergoing the same procedure reporting only 1 complication, which was hypertrophic scarring. Egrari performed 123 brachioplasties with and without simultaneous liposuction and no mention on the ratio. He had a 4.1% complication rate with 5.7% reoperation rate (4 hypertrophic scarring, 3 recurrent laxities).

Thus it may seems that complication rate after brachioplasty is fairly low and simultaneous liposuction can further lower it probably by lessening the wound closure tension.

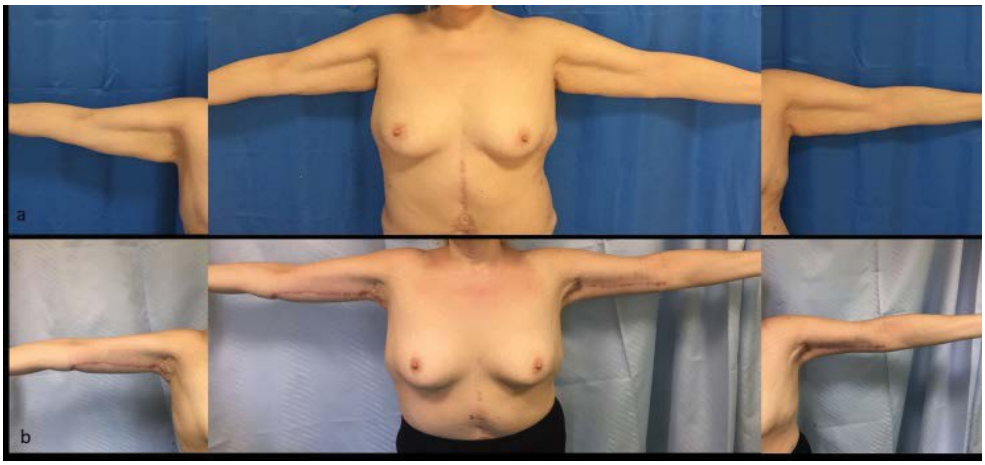

Figure 3: Brachioplasty. A 48 years old woman with (a) An excess of loose brachial skin after losing 40 kg due to bariatric surgery (b) The same woman after brachioplasty.

Liposuction

Indication: There are differing schools of thought on the role and staging of liposuction in MWL (Massive Wight Loss) patients. Some surgeons prefer to perform simultaneous liposuction arguing that it allows one area to be treated and rejuvenated in one sitting while eliminating the need for extra surgery [46]. However, significant oedema caused by the procedure can not only reduce the vascularity of the flaps, it may even compromise the final outcome [46]. Others opt to perform liposuction six months prior to the excision. Debulking of the area is thus achieved and the potential risks to the flaps due to resultant oedema are also eliminated [46]. The demerits are an extra surgical stage, hospitalization, increased costs and additional recovery time. In addition, the tissues may be stiffer making the later flap advancement more problematic [46].

Surgical technique: The evolution of liposuction has revolutionized the possible body contour results. Since the beginning of 1976, when Fischer described the first liposuction and through the popularization of this procedure by Illouz [47]. In 1983 Fournier introduced the early liposuction relied on the dry method without subcutaneous infiltration. In 1993, Klein discussed the tumescent technique that used massive infiltration of the subcutaneous tissue [47]. Historically; four types of wetting solutions have been used for liposuction: dry, wet, superwet and tumescent. The essential difference between these techniques focuses on the amount of fluid infiltrated into the tissues and the resultant blood loss as a percentage of aspirated fluid [48]. The most widely used technique is the tumescent; under general or local anaesthesia; depending on the amount of adipose tissue to be aspirated and the clinical conditions of the patients. Tumescent fluid is injected [48], infiltration begins by creating a small stab incision, just enough to accommodate the infiltration needle. Blunt-tipped cannulas of varying lengths are used to infiltrate the fluid into the desired deep subcutaneous adipose layer, using either a hand piece or foot pedal to control administration [48]. The suction cannula is introduced into the deep fat layer. The vacuum is activated and the cannula is pushed through the fat, creating a radial pattern [48]. Cross-hatching, or inserting the cannula from two different axes (usually perpendicularly), creates a smoother result [48]. Connected to the aspirator (or sometimes a syringe), the liposuction cannula is placed through the insertion site while the non-dominant hand (also known as 'the thinking hand') continually monitors the placement and trajectory of the cannula, enabling the surgeon to feel the progress in the area and to determine the end point of surgery [48].

In general, blunt-tip cannulas are used to minimize perforation risk, and smaller diameter cannulas are used to minimize contour irregularities [49]. Non–blunt-tip cannulas are typically used for breaking up scar or discontinuous undermining [49]. Aspiration has been found to be directly proportional to cannula and suction-tubing diameter and inversely proportional to cannula and suction- tubing length [49]. Specific depths of subcutaneous fat should be suctioned, which vary from different body locations and patient-specific goals [49]. The syringe technique used blunt-tip suction cannulas connected to a syringe. In case of manual liposuction the drawing back the syringe plunger generates the negative pressures needed to remove fat during liposuction and replaces the electric vacuum pump and connecting tubing [49,50]. Power-assisted liposuction is a commonly used technology that uses a variable-speed motor to provide reciprocating motion to the cannula which, in combination with the reciprocating action of the surgeon's arm, facilitates removal of adipose tissue [49,51]. The principal advantages of power assisted liposuction are treatment speed, economy of motion, and reduced operator fatigue [49,51] (Figure 4).

Ultrasound-assisted liposuction: Ultrasound-assisted liposuction uses ultrasound vibration of the cannula to break down connective tissue and emulsify fat [47]. The thermal energy produced has been reported to help with skin tightening but also has been associated with higher rates of complications.85 currently, some authors reserve ultrasound-assisted liposuction for tissue areas with more fibrous and dense connective tissue [47]. Newer generation devices have smaller diameter probes that can disperse energy in variable patterns [52]. Ultrasound is the process which turns electric energy into mechanical vibrations that cause thermal effects and micro-mechanical effects (acoustic) or cavitational effects in contracting and expanding circles. This causes microcavities in the fat tissue, which burst, resulting in cell destruction and fat liquefaction [53]. The thermal effect in fatty cells spreads to the surrounding tissues which are infiltrated by liquids at ambient temperature. There are three main physiological effects the ultrasound has [47]. The micromechanical effect is the injury produced directly by the unidirectional action of the ultrasonic waves through intracellular, organic molecules [47]. It has minimal effects. As previously mentioned cavitational effect, produces important cell fragmentation and diffusion of the lipidic matrix through the intercellular space [47]. The thermal effect is caused by acoustic waves, cannula friction, and the conversion of the ultrasonic waves into heat as they pass tissue [47]. The heat must be dissipated by tissue infiltration [54]. One

Figure 4: Liposuction. A 58 years old woman with an (a) excess adipose tissue at level of legs (b) Adipose tissue after a massive tumescent liposuction (c) Same woman after three months from liposuction of the legs.

of the most important aspects that distinguish ultrasound-assisted liposuction from other methods of liposuction is the final result on the postoperative haematocrit level [47]. With ultrasound-assisted liposuction there is better vessel preservation and consequently, less haematocrit decrease [47]. Another positive aspect of this technique is the possibility of greater skin retraction in the treated areas, as the increased local temperature stimulates collagen contraction. Zocchi et al. [54]. reports that superficial ultrasound-assisted liposuction has 40% more skin retraction than other methods. The disadvantages of ultrasound-assisted liposuction are the increased operative time and the training necessary for to efficiently use the technique and the equipment. In addition, swollen and fibrotic areas necessitate extended postoperative lymphatic drainage [47].

Laser-assisted liposuction: Laser-assisted liposuction (LAL) can be used to treat defined areas in the body, with claims of producing skin tightening and thermal coagulation to minimize bleeding. Different kinds of LAL have recently been developed and some are still at the experimental stage. An initial type of LAL has been tested by Apfelberg [55,56]. The operator inserts the cannula (special design, single holed, 4-6mm diameter), activates the suction, and then depresses the foot pedal to activate the laser. The negative suction draws the fat globule into the hole of the cannula where the laser beam (YAG laser 40W) shears it off bloodlessly. Apfelberg et al. concluded in their multicentre study that there was no clear and significant benefit to be gained from LAL over conventional liposuction [55,56]. The disadvantages are the slightly cumbersome and awkward equipment, and the fact that experience in laser use is essential. The only advantages are greater ease and less arm motion fatigue. In 2000 Neira used the Low-Level Laser-Assisted Lipoplasty (LLLAL) [55,57]. Low-level laser therapy is defined as treatment with a dose rate that causes no immediate detectable temperature rise in the treated tissue and no macroscopically visible changes in tissue structure [55,57]. The LLLAL consists of the tumescent liposuction technique with the external application of a cold laser (635 nm and 10 mW intensity for a 6-minute period) through the skin. However, in 2004, Brown et al. analysed the effect of low-level laser therapy on abdominal adipocytes before lipoplasty procedures and their results did not bear out the effect of low-level laser therapy on adipocyte structure [55,58]. A third innovative laser technique is the use of a pulsed Nd-YAG laser beam (1064 nm) delivered via an optical fibre of only 300 micrometres inserted in a 1 mm cannula. After lipolysis, the liquid fat is suctioned by a 3 mm cannula. Proposed indications are flaccid areas, small areas, secondary liposuction and difficult cases [55,59].

Complications and outcomes: Hypesthesia, paresthesias, edema, ecchymosis, hematoma, seroma and infection usually resolve quickly [48]. Hematomas and seromas may need to be drained with large needles or skin incisions. Infections often resolve with oral antibiotics, although a low incidence of devastating necrotizing fasciitis has been reported [48]. Fat emboli can be fatal but are rare. Skin necrosis can occur, usually as small areas, but it can usually be treated conservatively with local wound care. Pulmonary edema has been reported as a complication of tumescent liposuction [48]. The most common long-term complication is contour irregularity [48]. This relates to the experience of the individual surgeon and may respond to massage therapy [48]. It should be treated conservatively for at least 6 months [5]. Autologous fat grafting, further liposuction or skin excision should be performed as needed [5]. Various studies state minor revision rates of 2–10% [48]. In January 2000, Grazer published an article in which he reported the fatal outcomes of liposuction using a census survey of cosmetic surgeons [60]. Of those surveyed, 917 surgeons reported that from 1994–1997, 95 fatalities occurred after 496,245 lipoplasties [60]. This yields a mortality rate of 1 in 5224 (<0.5%). This is similar to rates quoted elsewhere [60]. Pulmonary thromboembolism was the major cause of death in 23.4 (± 2.6%) of these deaths [60]. The American Society of Plastic Surgeons recommends that outpatient lipoplasty be limited to 5000 ml of total aspirate, irrespective of the technique [48].

Thighplasty

Indication: The extent and type of the deformity in the thigh of ex obese patients is extremely variable. Some male patients never deposit much fat in the thighs and thus lower body lift alone may achieve the acceptable thigh contours [46]. Others may present with loose circumferential skin-fat envelope. These patients should undergo an excisional procedure only after a lower body lift to lift the lateral, posterior and upper-anterior thigh [46]. However, most female ex obese patients demonstrate a minimally deflated thigh despite an overall excellent weight loss. These patients should undergo concomitant liposuction of the thighs with the lower body lift, in preparation for a thigh reduction procedure to be performed six months later [46]. In a nutshell, in order to attain acceptable contours; the thighs should be deflated either by massive weight loss process, or surgically by liposuction before the final excisional procedure [46].

It is recommended to perform thighplasty six months after the body lift operation [46]. Lower body lift procedures have beneficial effect on the lateral thigh and on the proximal anterior thigh. The improvement in the thighs often reduces the extent of the thigh reduction surgery [46]. Any evidence of lymphoedema or significant venous problems should be considered as contraindications for thighplasty. If horizontal excision is being incorporated, it is important to evaluate the degree of the traction transmitted across the perineal junction to the labia majora [46].

Surgical technique: Although the lower body lift corrects lateral thigh laxity, it does little to address skin laxity in the medial thigh. Two procedures are described to contour the medial thigh, the vertical excision and the horizontal excision [61]. The vertical excision provides more reliable results in correcting medial thigh skin laxity. Some authors advocate the use of liposuction at the excision site. Although a transverse-only medial thigh excision is appealing, this procedure is very underpowered and only corrects skin laxity in the uppermost part of the medial thigh [61]. Anchoring to Colles fascia, as described by Lockwood, helps suspend the tissues after transverse resection, but it is vital to understand that the force of pull is not transmitted to the distal thigh [61]. Aggressive transverse medial thigh lift can lead to significant cosmetic and functional problems and is not a substitute for a vertical thighplasty if that operation is indicated [61].

While performing medial thigh lift the superficial lymphatic structures and the great saphenous vein and its branches require special attention. The lymphatics of the leg are primarily concentrated medially and lie deeper than the saphenous vein until they coalesce in the femoral triangle [46]. Injury to the lymphatics here can lead to disabling lower limb oedema which is usually permanent. In patients with significant varicose vein problems, the saphenous vein may also be excised along with medial skin resection [46].

Vertical thigh lift: The technique of vertical medial thigh lift incorporates the excision of the vertically oriented wedge of the

excess skin located on the medial aspect of the thigh. It uses both an anterior and posterior horizontal vector while totally eliminating the vertical vector/pull, to accomplish thigh contouring. The horizontal incision in the groin is limited to the correction of the 'dog-ear' and does not contribute to the actual lift of the medial thigh. There is no need to anchor the thigh flaps to the Colles' fascia [46].

The vertical line should terminate at a point just distal to the deformity to be treated (typically, the junction of the knee with the leg). The line should not be visible when evaluating the standing patient from either an anterior or a posterior perspective [62]. As Grieco et al. [63], described the patient is marked first in standing position then in a supine position, with flexed thighs and abducted knees and confirmed with the patient in horizontal dorsal decubitus. The horizontal line is marked from the inguinal crease in the direction of the gluteus groove, while the final vertical line is marked in the median portion of the internal face of the thigh from the inguinal region to the internal facet of the knee. The resection limits of the spindles are determined by pinch test. The lower limbs are placed in a flexed and abducted position. Resection of skin and subcutaneous tissue, previously determined by markings, is performed. The depth of excision should be just below Scarpa's fascia but above the level of the saphenous vein. Then, the planned amount of skin and subcutaneous tissue may be respected. Suture is performed under tension, on three planes (subcutaneous, subdermal and intradermal); suction drains are placed and maintained 1-2 days postoperatively. For all patients, antibiotic therapy is administered in the immediate pre-operative period, and continued for 5 days. Postoperative care includes 10 days of treatment with low molecular weight heparin to prevent major complications such as deep vein thrombosis and pulmonary embolism. Social activity is limited for 4 weeks after the discharge [63].

Horizontal thigh lift: Plastic surgeons often are asked to carry out horizontal medial thigh lifts because the skin of this area has poor elasticity, which induces excess skin. Moreover, the upper fat deposit may disturb the patient, leading to rubbing, with irritation, and even functional problems [64].

As described by Labardi et al. [65] the upper incision line is drawn in the inguinal groove, with the anterior end that comes to the average femoral triangle and the posterior end that reaches the middle of the gluteal groove. Then the inferior line is made, based on the amount of skin to be removed as calculated by the pinch test, and an ellipse, which is usually between 4 and 6 cm, is drawn. The patient is placed on the operating table in a gynaecological position. The procedure starts with the proximal line incision, superficial dissection to preserve the superficial lymphatic network at the femoral triangle. After identifying the fascia of Colles, it is anchorated with non-absorbable sutures to the dermis of the upper and lower skin flap. This leads to less tension on the scar and more lasting results over time [65].

Le Louarrn et al. [64] reported a new horizontal technique with a new incision line located along the labia major in the perineal crease remains at the same height backward, a concentric medial thigh lift. The incision never descends into the buttock fold. No undermining at all occurs even in the resection area. The resection removes only the skin layers (epidermis and dermis). The direction of the skin stretching is concentric toward the labia minor. Consequently, the length of the scar is shortened at both its anterior and posterior parts. Anchor sutures pull a no undermined skin, avoiding necrosis and closing dead space [66]. The traditional medial thigh lift techniques are marred by the problems of inferior wound migration, lateral traction deformity of vulva/ labia majora, widening of the scars and early recurrence of ptosis [46]. The Lockwood's classic horizontal resection and fascial anchoring technique for medial thigh lift designed to prevent labial spreading and migration of the perineal scar allows a more stable long-term result [46,66].

Complications and outcomes: Despite the many technical variations of medial thighplasty, there are very few studies investigating objective outcomes and complications in the massive weight loss population. Because of movement, moisture, and a potential T-point in the groin crease, complication rates may be high [67].

As reported Capella et al in a review of 350 vertical medial lift with liposuction cases (700 thighs), 45.14 percent of patients experienced a complication. Skin dehiscence was the most frequent complication at 31.14 percent. Seromas are the second most frequent complication at 18.18 percent. The vast majority, approximately 90 percent, occur along the distal medial third of the thigh and lie immediately beneath the scar [62].

Sisti et al analysed 16 studies from 1988 to 2015. Overall, 447 patients were treated. Different techniques were applied. Complications were observed in 191/447 patients (42.72%). The most frequent complications were: wound dehiscence (82/447 patients, 18.34%) seroma (36/447 patients, 8.05%), wound infection (21/447, 4.96%) hypertrophic scarring (11/447 patients, 2.4%), and scar migration (16/447 patients, 3.57%). Rare complications were partial skin necrosis (one patient) and lymph fistula (one patient) [68].

However, with a careful preoperative assessment, properly selected patients reported substantial improvements in overall functioning and psychosocial health [7]. Understanding the risks of medial thighplasty is important for patient counselling and the informed consent process [7].

Discussion

In 1949, the World Health Organization (WHO) defined health as "complete physical, mental, and social well-being and not merely the absence of disease or infirmity' [61]. Morbid obesity has significant impact on patients' physical and psychosocial conditions. There is negative interference in daily activities, overall quality of life, psychosocial distress and co-morbidities, such as hypertension and diabetes mellitus among others [7]. The increased prevalence of successful bariatric surgery procedures over the past two decades has resulted in a variety of body contour deformities in the massive weight loss patient that were not commonly seen by plastic surgeons in the past [67]. For cosmetic reasons, body-contouring surgery cannot be performed before a stable body weight has been achieved and maintained for up to 6 months [5].

In modern aesthetic plastic surgery and health management, quality of life (QoL) is being increasingly accepted as a relevant endpoint [7,69]. QoL is defined as a "multidimensional construct that includes physical, social, psychological, emotional, or spiritual domains to arrive at an assessment of a patient's state of being" [7,69]. Aesthetic post-bariatric surgery removes the excess skin that is present after the massive weight lost (MWL) that follows bariatric surgery [63]. Excess skin is predominantly found on the upper arms, breasts, abdomen, and thighs. It can interfere with mobility and physical exercise and may lead to intertrigo, ulceration, and infection [7,69]. In patients who undergo body contouring surgery,

the redundant skin following MWL has an adverse effect on QoL, self-esteem, body image perception, and physical functioning [7,69]. A key component of body contouring after massive weight loss is managing patient expectations. Understanding the risks of body contouring's procedures is important for patient counseling and the informed consent process [7,69].

As Abdominoplasty is a safe and effective surgical technique for the correction of body contour in patients with massive weight loss after bariatric surgery. Diet and exercise cannot deal with excess skin after extreme weight loss. Generally, the risk of complications is higher compared to a cosmetic abdominoplasty. Despite this, many patients undergo a functional abdominoplasty, as this surgical technique allows a better quality of life in these ex-obese patients [6,7, 63,67].

In MWL patients, excess skin and fat present around the arms in between the elbow and the axilla. This is often an area of concern for women due to difficulty finding clothes that fit and inability to "hide" the deformity often likened to wings [63].

The brachioplasty is not a simple technique, requiring a long learning curve, but it confers natural arm shape and profile, reproducing the inferior concavity proximal to the elbow [63]. Despite its frequency, thighplasty is an operation commonly associated with high complication rates and poor aesthetic outcomes in the massive weight loss population [63,67]. Liposuction-assisted procedures represent a further step in technical refinements of body contouring surgery, which is potentially able to improve outcomes [70].

Moreover, it should be stressed that adipose-derived stem cells are recognized as being an effective mesenchymal stem cell population with enormous potential in different fields of regenerative medicine and stem cell therapy [71-91].

Conclusion

In Western countries, obesity is a major issue for health, economics and psychology. Bariatric surgery has allowed them to give a second chance to these patients. The role of body countering is to improve the results obtained through bariatric surgery or diet therapy by returning a patient's accepted body profile that allows their social reintegration. Significant for the surgeon is managing patient expectations and clarifying to him the risks of body contouring's procedures.

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