Skin changes and manifestations associated with the treatment of obesity

Jordan Rosen, BS,[a] Evan Darwin, BA,[a] Sara Moradi Tuchayi, MD, MPH,[b,c] Lilit Garibyan, MD, PhD,[b,c] and Gil Yosipovitch, MD[a]
Miami, Florida; and Boston, Massachusetts

Learning objectives
After completing this learning activity, participants should be able to discuss the effects of weight loss and weight loss procedures on both dermatologic diseases and their therapies; discuss the efficacy and adverse skin effects associated with medications frequently used for weight loss; and characterize the effects of excess skin following weight loss procedures on quality of life and assess the treatment options.

Disclosures
Editors
The editors involved with this CME activity and all content validation/peer reviewers of the journal-based CME activity have reported no relevant financial relationships with commercial interest(s).

Authors
The authors involved with this journal-based CME activity have reported no relevant financial relationships with commercial interest(s).

Planners
The planners involved with this journal-based CME activity have reported no relevant financial relationships with commercial interest(s). The editorial and education staff involved with this journal-based CME activity have reported no relevant financial relationships with commercial interest(s).

In light of the increasing prevalence of obesity, a large proportion of patients are taking weight loss medications or undergoing weight loss procedures. The typical paradigm for treating obesity begins with lifestyle interventions and progresses to medical treatments, and when nonsurgical interventions have failed, procedural techniques are considered. The effect of these interventions on the skin and dermatologic conditions has not been reviewed in depth. Herein, we review the impact of weight loss on pre-existing dermatologic conditions, as well as the development of novel skin changes and consequences of redundant skin after these interventions. (J Am Acad Dermatol 2019;81:1059-69.)

Key words: bariatric surgery; cryolipolysis; dermatology; liposuction; obesity; redundant skin; skin changes; weight loss; weight loss medications.

In the context of obesity, weight reduction is associated with reduced mortality and morbidity and in improvements in quality of life.[1-3] However, both short-term and long-term reduction in weight can be extremely difficult for patients and often requires the assistance of health care

From the Dr Phillip Frost Department of Dermatology & Cutaneous Surgery, University of Miami Miller School of Medicine[a]; Wellman Center for Photomedicine, Massachusetts General Hospital, Boston[b]; and Department of Dermatology, Harvard Medical School, Boston.[c]
Funding sources: None.
Conflicts of interest: None disclosed.
Accepted for publication October 17, 2018.
Reprints not available from the authors.
Correspondence to: Gil Yosipovitch, MD, 1475 NW 1st Ave, Miami, FL 33136. E-mail: gyosipovitch@med.miami.edu.
0190-9622/$36.00

https://doi.org/10.1016/j.jaad.2018.10.081

Date of release: November 2019
Expiration date: November 2022

Scanning this QR code will direct you to the CME quiz in the American Academy of Dermatology's (AAD) online learning center where after taking the quiz and successfully passing it, you may claim *1 AMA PRA Category 1 credit*. NOTE: You must have an AAD account and be signed in on your device in order to be directed to the CME quiz. If you do not have an AAD account, you will need to create one. To create an AAD account: go to the AAD's website: www.aad.org.

Abbreviations used:

FDA: Food and Drug Administration
GLP-1: glucagon-like peptide 1
HS: hidradenitis suppurativa
TNF: tumor necrosis factor

professionals. Methods of weight loss vary from lifestyle changes (eg, exercise, dieting) to invasive interventions (eg, bariatric surgery). Oral weight loss agents may be used in patients who fail to respond to lifestyle changes. Weight loss procedures, such as bariatric surgery, are generally reserved for patients with morbid obesity (body mass index $\geq$40 kg/m^2) or obesity and obesity-related comorbidities.[4] These interventions, to varying degrees, can help patients with obesity reduce their weight and their risk of obesity-related sequela.[4] Depending on the weight loss intervention, a variety of dermatologic changes might occur in these patients. Dermatologists need to be aware of these associations to properly inform patients who are considering, undergoing, or who have undergone weight loss interventions. Herein, we review the dermatologic changes and consequences associated with loss of subcutaneous adipose tissue.

WEIGHT LOSS THERAPIES

Key points

- **Dermatologic side effects of injectable weight loss medications include infection, erythema, bruising, hematoma, induration, fibrosis, subcutaneous granulomatous nodules, and cutaneous ulcerations.**
- **There are many different medications for weight loss, each with unique potential dermatologic benefits and side effects.**
- **Surreptitious use of medications not approved for weight loss is frequent among patients seeking to lose weight or increase their muscle mass. Dermatologists should be aware of the cutaneous side effects of these medications.**

Oral medications for weight loss

The variety of weight loss prescriptions have increased tremendously over the past decade, and dermatologists should be aware of their cutaneous effects (Table I).[5-49] Some of these medications can be beneficial for both weight loss and dermatologic disease, and many are associated with adverse cutaneous effects.

Synthetic amines (eg, phentermine and benzphetamine) can cause a 5% weight loss by decreasing food intake and increasing satiety.[5] These medications are congeners of amphetamines, and although only Food and Drug Administration (FDA)—approved for short-term use, they are among the most widely used antiobesity medications.[50] Amines have minimal dermatologic symptoms but have been associated with xerosis, scleroderma,[7] and urticaria.[8]

Metformin has been used off-label as an anorexigenic drug (Level of Evidence 4).[9] For obese patients seen in dermatology, this drug has additional benefits in many cutaneous conditions, including hirsutism (Level of Evidence 1b),[10] acne (Level of Evidence 1b),[11,12] hidradenitis suppurativa (Level of Evidence 2b),[12,13] acanthosis nigricans (Level of Evidence 2a),[14] eruptive xanthomas (Level of Evidence 3),[12] psoriasis (Level of Evidence 3),[15] and skin cancer.[16,17] However, cutaneous side effects have been reported, including leukocytoclastic vasculitis,[18] bullous pemphigoid,[19] psoriasiform drug eruption,[12] lichen planus,[20] and acute alopecia.[12]

Topiramate—initially approved as an anticonvulsant—was also discovered to have significant weight loss properties. This weight loss is potentially caused by the drug's effects on neuropeptide Y, corticotrophin-releasing hormone, and type II glucocorticoid receptors.[21] Topiramate is commercially approved for use in combination therapy with phentermine for weight loss[21] and has been reported to induce hypohidrosis,[22] delusions of parasitosis,[23] palmar erythema,[24] and pruritus.[25]

Another combination therapy approved by the FDA for weight loss is naltrexone-buproprion.[8] Naltrexone is an opioid antagonist that can affect obesity by blocking the action of β-endorphin at the μ-opioid receptor.[26] The antidepressant bupropion acts by inhibiting the reuptake of dopamine and noradrenaline.[26] Case reports suggest that these medications can also induce pustular psoriasis,[27] pityriasis rosea-like drug eruptions,[28] subacute cutaneous lupus erythematosus,[29] serum-sickness reaction,[30] acute generalized exanthematous pustulosis,[31] and aquagenic pruritus.[32] More serious potential adverse reactions include erythema multiforme, hypersensitivity reaction, and Stevens-Johnson syndrome.[51]

Liraglutide is an analog of glucagon-like peptide 1 (GLP-1) that has shown consistent weight loss results in clinical trials.[52] Case reports indicate that obese

Table I. Summary of therapies for weight loss

Medications	Mechanism of action	Dermatologic benefits	Dermatologic side effects
Injectables			
Deoxycholic acid	Activates a local tissue response of macrophages and fibroblasts that causes adipocytolysis[6]	None	Atypical mycobacterial infections,[33] erythema, bruising, induration, hematomas including fibrosis,[34] subcutaneous granulomatous nodules,[43] skin necrosis,[44] and cutaneous ulcerations[44]
Mesotherapy	Variable depending on the formulation	None	Atypical mycobacterial infections,[33] erythema, bruising, induration, hematomas including fibrosis,[34] subcutaneous granulomatous nodules,[43] skin necrosis,[44] cutaneous ulcerations,[44] psoriasis,[48] and granuloma annulare[49]
Weight loss medications			
Phentermine	Synthetic amine, decreases appetite, and increases satiety[5]	None	Xerosis, scleroderma,[7] and urticaria[8]
Metformin	Anorexigenic drug (Level of Evidence 4)[9]	Hirsutism (Level of Evidence 1b),[10] acne,[11] hidradenitis suppurativa,[13] acanthosis nicrcans,[14] eruptive xanthomas,[12] psoriasis,[15] and skin cancer[16,17]	Leukocytoclastic vasculitis,[18] bullous pempigoid,[19] psoriasiform drug eruption,[12] lichen planus,[20] and acute alopecia[12]
Topiramate	Effects on neuropeptide Y, corticotrophin-releasing hormone, and type II glucocorticoid receptors[21]	None	Hypohidrosis,[22] delusions of parasitosis,[23] palmar erythema,[24] and pruritis[25]
Naltrexone-bupropion	Blockade of β-endorphin action at the μ-opioid receptor.[26]	None	Pustular psoriasis,[27] pityriasis rosea-like drug eruptions,[28] subacute cutaneous lupus erythematosus,[29] serum-sickness reaction,[30] acute generalized exanthematous pustulosis,[31] erythema multiforme, Stevens-Johnson syndrome, and aquagenic pruritus[32]
Liraglutide	An analog of GLP-1	Psoriasis[35-37]	Vesiculopustular dermatosis[38]
Orlistat	Inhibits the absorption of ingested dietary fats[39]	None	Lichenoid drug reactions[40] and bullous leukocytoclastic vasculitis[41,42]
Lorcaserin	Selective serotonin (5-HT2c) agonist	None	Serotonin syndrome
Surreptitious medications			
Laxatives	Decreased absorption of nutrients	None	Photosensitivity, urticaria, fixed drug eruptions, and finger clubbing[45]
Amphetamines and prescription amines	Anorexigenic stimulants	None	Xerosis, pruritus, body odor, hyperhidrosis, xerostomia, premature aging,[46] acne excoriee, and lichenoid drug eruptions[47]

GLP-1, Glucagon-like peptide 1.

patients with psoriasis might have clinical improvement in their skin disease from liraglutide therapy (Level of Evidence 3).[35-37] However, a potential cutaneous side effect of the medication is vesiculopustular dermatosis.[38]

Orlistat has been approved since 1999 for weight loss but gastrointestinal side effects have limited its use. Orlistat acts as a reversible inhibitor of pancreatic and gastric lipases, inhibiting the absorption of dietary ingested fats.[39] Orlistat can affect the absorption of fat-soluble vitamins A, D, E, and K and produce the cutaneous side effects associated with those deficiencies. In addition, case reports have described cutaneous side effects, including lichenoid drug reactions[40] and bullous leukocytoclastic vasculitis.[41,42]

Lorcaserin is a selective serotonin (5-HT2c) agonist that is FDA approved to treat obesity.[53] When combined with other serotoninergic agents, locaserin can induce serotonin syndrome, leading to high body temperature, agitation, increased reflexes, tremors, sweating, dilated pupils, and diarrhea.[54]

Surreptitious use of medications for weight loss

Many drugs, such as laxatives and stimulants, have been misused for the purposes of weight loss. Laxatives cause weight loss via dehydration and a decreased absorption of nutrients but can also induce skin diseases, such as photosensitivity, urticaria, fixed drug eruptions, and finger clubbing.[45] Stimulants, such as amphetamines and 2-4 dinitrophenol, have a known anorexigenic effect but can also cause xerosis, pruritus, malodor, hyperhidrosis, xerostomia, premature aging, skin necrosis, acne excoriee, or lichenoid drug eruptions.[46,47]

WEIGHT LOSS PROCEDURES

Key points

- **Bariatric surgery is an effective means of weight loss that can result in improvements in hidradenitis suppurativa and psoriasis but might also result in nutritional deficiencies, bowel-associated dermatosis-arthritis syndrome, PASH (pyoderma gangrenosum, acne, and hidradenitis suppurativa [HS]), vasculitis, and redundant skin.**
- **In addition to removing subcutaneous fat, liposuction might improve lymphedema but might also result in skin redundancy, bleeding, skin necrosis, and infection.**
- **The potential dermatologic side effects of cryolipolysis include temporary mild inflammation, nerve damage, and paradoxical adipose hyperplasia.**

Bariatric surgery

With >200,000 procedures performed annually in the United States, bariatric surgery has become a legitimate option in combating obesity (Table II).[55] Bariatric procedures are categorized as restrictive, malabsorptive, or restrictive malabsorptive. Whereas restrictive procedures (eg, sleeve gastrectomy) intend to limit the gastric capacity, malabsorptive procedures (eg, biliopancreatic diversion) act to reduce the absorption of food. The most commonly performed bariatric procedure, Roux-en-Y gastric bypass, utilizes both these techniques and is hence categorized as restrictive malabsorptive.[56] Although bariatric surgery is associated with reductions in comorbidities related to obesity and metabolic syndrome, a variety of other effects have been reported.[57]

Pre-existing dermatologic diseases after bariatric surgery. *Hidradenitis suppurativa.* Associations between HS and obesity have been well reported[58]; however, the effects of substantial weight loss after bariatric surgery have not been well established. Improvements in metabolic abnormalities (eg, insulin resistance) and reductions in the chronic inflammatory state associated with obesity can explain improvements in HS after bariatric surgery.[59] Case reports have noted rapid improvements of HS in the months after bariatric surgery.[60,61] Furthermore, in a retrospective survey of 35 patients with HS symptoms who received bariatric surgery, 24 patients (69%) demonstrated improvements, 7 patients (20%) demonstrated no change, and 4 patients (11%) experienced worsening of HS symptoms.[59] Conversely, anecdotal evidence of HS patient internet forums demonstrated that most patients report unchanged or worsening symptoms after bariatric surgery.[62]

Psoriasis. Patients with psoriasis who are overweight and achieve substantial weight loss can see improvements in psoriatic skin lesions.[63] Likewise, improvements in quality of life, severity of psoriasis, and, interestingly, reductions in the incidence of psoriasis have been reported after bariatric surgery.[64-66] These findings, however, are based largely on case reports and retrospective surveys. Most patients reported significant improvements in psoriasis within 1 year.[67] In a retrospective survey, 62% noted improvements, 26% no change, and 12% worsening of their psoriasis after undergoing bariatric surgery.[64] Proposed explanations for the improvements noted in psoriasis include decreased tumor necrosis factor (TNF) α or decreased leptin (an inflammatory hormone originating from adipose cells that can increase T-helper 1 activity and TNF-α production).[68] The improvements in

Table II. Summary of weight loss procedures

Procedure	Mechanism of action	Dermatologic benefits	Dermatologic side effects
Bariatric surgery	Reduction in gastric capacity or food absorption	Hidradenitis suppurativa, psoriasis, necrobiosis lipoidica, acanthosis nigricans	Nutritional deficiencies, alopecia, bowel-associated dermatosis-arthritis syndrome, PASH, angiosarcoma, vasculitis
Liposuction	Aspiration of subcutaneous fat	Lymphedema	Skin redundancy, bleeding, skin necrosis, infection
Cryolipolysis	Selective damage to adipocytes	Improved skin contour	Paradoxical adipose hyperplasia, temporary mild pain, erythema, altered sensations

PASH, Pyoderma gangrenosum, acne, and hidradenitis suppurativa.

psoriasis might be related entirely to the weight loss and not the surgery. However, the mechanism underlying improvement in psoriasis after bariatric surgery might not be entirely reliant on the nonspecific changes seen in any form of weight loss. Some studies have reported that patients undergoing restrictive-malabsorptive surgeries report greater improvements in psoriasis and greater reductions in the incidence of psoriasis than those undergoing restrictive surgeries.[69] The reason for this discrepancy is unknown but might in part be explained by significant increases in GLP-1 after gastric bypass surgery.[64] GLP-1 is a gut-derived hormone involved in glucose metabolism. As mentioned earlier, GLP-1 analogs used to treat diabetes (eg, liraglutide) can also cause weight loss. The protective effects against psoriasis might be related to reductions in inflammation, inhibition of downstream TNF-α effects, and regulatory T-cell preservation and proliferation.[64]

Diabetic skin changes. Bariatric surgery has also been associated with changes in other dermatologic conditions associated with metabolic syndrome. Improvements in acanthosis nigricans have been reported; however, these changes are more likely directly related to improved control of diabetes mellitus.[70] Necrobiosis lipoidica has also been reported to improve after bariatric surgery.[71]

Dermatologic manifestations after bariatric surgery. *Nutritional deficiencies.* Insufficient levels of nutrients are common among those with obesity, and nutritional status commonly worsens after bariatric surgery.[57] The most frequently encountered nutrient deficiencies after bariatric surgery are vitamin B12, vitamin B1, vitamin C, folate, vitamin A, vitamin D, vitamin K, iron, selenium, zinc, and copper.[72] Nutritional deficiencies might manifest as skin changes.[73] Despite an emphasis on micronutrient supplementation, nutritional deficiency in this population remains common, likely because of their difficulty maintaining lifelong adherence to nutritional supplementation and poor follow-up.[74-76]

Alopecia. A wide range of patients (12%-93%) report some degree of alopecia after bariatric surgery.[77-81] Telogen effluvium in association with nutritional deficiencies of zinc and iron is usually reported beginning 6 months after surgery.[82-84] Improvements in alopecia have been reported with appropriate vitamin supplementation and is often recommended for patients with alopecia after bariatric surgery.[80,85]

Bowel-associated dermatosis-arthritis syndrome. Bowel-associated dermatosis-arthritis syndrome is a neutrophilic dermatosis characterized by arthralgias, myalgias, fever, and inflammatory macules, papules, or pustules. This disease classically presents after gastrointestinal surgery (eg, bariatric surgery) or in the context of inflammatory bowel disease, and the initial presentation is often 3 months to 5 years after the inciting procedure.[86] Although intestinal bypass surgeries are classically associated with bowel-associated dermatosis-arthritis syndrome, nonbypass gastrointestinal procedures (eg, sleeve gastrectomy) have also been linked to this syndrome.[57] The pathophysiology of bowel-associated dermatosis-arthritis syndrome is uncertain; one prevailing theory is that intestinal bacterial overgrowth induces an immune response—possibly to bacterial peptidoglycans—that increases antigen-antibody complex formation and deposition.[86,87]

Other conditions. A number of other dermatologic conditions have been reported after bariatric surgery. Many of these associations rely on a limited number or (in some cases) a single case report. These other conditions include PASH, angiosarcoma, dermatitis herpetiformis, and vasculitis (Henoch-Schnolein purpura, necrotizing vasculitis, and panniculitis).[57,88]

Liposuction

Liposuction is the procedure of changing the body contour by aspiration of subcutaneous fat after

injection of saline and is not considered a weight loss procedure.[89] Liposuction was developed by Yves Gerard Illouz,[90] and is the most frequently performed surgical method for fat removal.[91] More than 300,000 liposuction procedures were performed in the United States in 2017.[91] To avoid the need for blood transfusion, the amount of fat removed can be limited to 1500 mL; however, novel methods utilizing epinephrine enable the removal of >10 L of aspirate with minimal risk of blood loss.[92] Complications of large-volume liposuction include aesthetic problems (eg, contour irregularities), but more serious complications, such as bleeding, infection, fat emboli, deep vein thrombosis, pulmonary embolism, and death, can also occur.[92,93] Skin changes associated with liposuction include skin redundancy or laxity, infection, and skin necrosis, which have been reported in 10%, <1%, and 1% of cases respectively.[94-96] Temporary skin findings after liposuction include ecchymosis, hyperpigmentation, and sensory loss.[95]

In 90% of patients, skin retraction occurs naturally to help reshape the body contour.[96] The skin retraction rate depends on genetics, degree of obesity, skin laxity, anatomic location, and procedure type.[96] Anatomic areas with higher proportions of fibrous septae in the superficial fat layer are thought to have the most skin retraction after liposuction. Thick septae in the back helps with retraction after liposuction in this area. Meanwhile, skin retraction in the medial thigh and upper abdomen after liposuction is poor.[97] Energy-assisted techniques, including ultrasound-assisted liposuction, laser-assisted liposuction, and radiofrequency-assisted liposuction, have been introduced to increase skin tightening after fat removal and enhance procedure efficiency.[98] Prospective studies with larger numbers of participants are needed to determine the overall effects of these energy-based techniques on skin tightening after liposuction.[99]

Physiologic improvements in lymphedema. Approximately 200 million patients have lymphedema worldwide, and there is a strong association with obesity.[100] A multidisciplinary approach involving conservative therapy and surgical methods are used to manage lymphedema and improve patient quality of life. Liposuction has been used to remove subcutaneous adipose accumulation and fibrotic tissue in patients with advanced lymphedema.[101] Increased blood flow, reduced lymph production due to decreased subcutaneous adipose tissue, and improved drainage of lymph from the superficial to the deep lymphatic system are the potential mechanisms for improvements in lymphedema after liposuction.[102] In spite of improvements in lymph transport with liposuction, patients need to wear compression garments, as the function of the lymphatic system does not return completely to its physiologic state.[102,103]

Metabolic effects. Large-volume liposuction results in the removal of a dramatic amount of fat; hence, there has been great interest in investigating if this method has favorable metabolic effects. Improvement in metabolic markers after liposuction has been reported in a number of studies; however, there are many potential cofounding factors that must be taken into consideration in such studies (eg, use of different outcome measurement methods, motivating effects of the procedure on diet, and exercise). A study of 15 obese diabetic and nondiabetic patients showed no evidence of metabolic or cardiovascular effects due to liposuction. Liposuction did not significantly affect the plasma level of proinflammatory cytokines associated with obesity (eg, C-reactive protein, interleukin 6, and TNF-α).[104,105] Liposuction only affects subcutaneous adipose tissue, and it is the visceral adipose tissue that is associated with higher risks of metabolic disease.[106,107]

COSMETIC PROCEDURES TO REDUCE SUBCUTANEOUS FAT

Injectable fat-removal therapy

Injectable medications can be used for localized fat reduction. The first injectable fat-removal medication approved by the FDA was deoxycholic acid (Level of Evidence 1b), which is currently only approved for treatment of submental fat (double chin).[108] Clinical practice recommendations for deoxycholic acid use include a strong knowledge of anatomy and injection site technique, pretreatment with lidocaine and nonsteroidal anti-inflammatory drugs, and cold application for pain management and posttreatment swelling (Level of Evidence 4).[108] Common dermatologic side effects from deoxycholic acid injection include injection site swelling, pain, numbness, hematoma, bruising, and erythema. Another medication used by practitioners for spot weight fat loss that is not approved by the FDA is mesotherapy.[109,110] Mesotherapy involves the local injection of a number of compounds (eg, B vitamins, isoproterenol). Injecting these medications typically results in minimal morbidity; however, there are potential side effects that dermatologists must consider. First, injectable medications present a risk for infections, such as atypical mycobacterial infections.[33,111] Second, common dermatologic side effects include injection site erythema, bruising, induration, and hematomas.[112] Other reported cutaneous reactions include fibrosis,[34] subcutaneous granulomatous nodules,[43] skin necrosis, and cutaneous ulceration.[44] In addition, case reports indicate

that mesotherapy might trigger psoriasis[48] or granuloma annulare.[49]

Cryolipolysis

Cryolipolysis is a noninvasive method for the reduction of subcutaneous fat by localized topical cooling. Cryolipolysis is used for the removal of only small amounts of subcutaneous adipose tissue in the flanks, abdomen, arms, thighs, and submental area. After 1 cycle of cryolipolysis to the flank, an average of 40 mL of adipose tissue is lost 2 months after treatment.[113] Selective damage to adipocytes through lipid crystallization—leading to apoptosis and panniculitis within the adipose tissue—is thought to be the mechanism of fat loss by cryolipolysis. Cryolipolysis leads to the reduction in the superficial layer of subcutaneous fat.[114,115]

Cutaneous side effects. Cryolipolysis is a safe procedure when done by using FDA-approved devices. Cutaneous side effects from cryolipolysis are minimal and, for the most part, appear immediately after treatment and resolve within a few weeks. Mild temporary side effects, such as erythema, pain, bruising, edema, and altered sensation, have been reported immediately after treatment in most patients.[116,117] Altered sensation occurs in more than two-thirds of patients and is characterized by decreased sensory function over the treated area lasting for weeks. In a previous study, quantitative sensory testing in 11 healthy patients revealed that cryolipolysis leads to prolonged but reversible loss of multiple sensory modalities.[118] Hyposensitivity to mechanical and thermal pain and vibration sensations developed in patients beginning 2-7 days after cryolipolysis, persisting for ~35 days after treatment and returning to baseline sensitivity levels by day 56.[118] Last, another rare potential side effect that can occur after cryolipolysis is paradoxical adipose hyperplasia.[119]

REDUNDANT SKIN

Key points

- **After massive weight loss, redundant skin can cause complications, including recurrent rashes, infections, and frictional discomfort.**
- **For many patients that have achieved massive weight loss, redundant skin is a major detriment to quality of life**
- **Body contouring surgery is the main treatment for redundant skin, but because this surgery is considered cosmetic, the cost can be a barrier to entry. As with all surgeries, there are inherent risks.**

Table III. Redundant skin

Category	Description
Skin physiology	Decreased elastin fibers, decreased and poorly organized collagen structure, chronic inflammation, increased vascularity[120,121]
Quality of life effects	Excess sweating, recurrent rashes, chafing from excess skin, intertrigo, cellulitis, tissue necrosis, dissatisfaction in body habitus[120,124]
Treatment	Body contouring surgery

After massive weight loss, many patients experience excess skin. Although weight loss is beneficial, redundant skin can be associated with skin pathology. Light et al demonstrated that collagen in redundant skin is disorganized, less dense, and thinner with increased cross-linking[120]; On the contrary, other studies have noted thicker collagen[121] and increased concentrations of type III and IV collagen (Table III).[122] Likewise, changes in elastin in redundant skin remain controversial. Some studies report degradation of elastic fibers,[120] and others report that elastin is undamaged.[123] Patients report excessive sweating, recurrent rashes, and chafing.[124] The excess skin folds can act as a nidus for infection, predisposing patients to intertrigo, cellulitis, and tissue necrosis.[120,124]

Beyond the clinical complications, redundant skin is associated with dissatisfaction in body habitus.[124] After bariatric surgery, many patients have greater displeasure cosmetically with the excess skin than they did with their appearance before surgery.[124] Patients report modifying their behavior to hide their sagging skin and describe feeling socially isolated and abnormal.[124] A new tool, the Sahlgrenska Excess Skin Questionnaire, was established to better quantify the effects of excess skin on patients' quality of life.[125] Perhaps this new questionnaire can be used in future studies to better understand the difficulties that patients face.

The only available treatment for excess skin is body contouring surgery. Overall, 74% of patients desire body contouring surgery after bariatric surgery, but only 21% undergo the procedure.[126] It is unknown why many patients do not undergo the procedure, although the high cost and the lack of insurance coverage might contribute.[126] Patient satisfaction regarding body contouring surgery after the procedure is typically high, and there have been demonstrable improvements in patient anxiety and

depression scales after the surgery.[126] However, as with all surgeries, there are inherent risks to the procedure, including hematoma, infection, seroma, wound dehiscence, necrosis, asymmetry, lymphedema, scarring, neuropathy, and deep vein thrombosis.[127]

CONCLUSION

As rates of obesity continue to rise in the world population, therapies and procedures to induce weight loss will become more prevalent. These therapies and the subsequent weight loss, though often beneficial to the patient overall, have cutaneous effects that must be understood for medical management. With optimal selection of treatments, morbidity can be minimized and, in some cases, cutaneous symptoms might even be improved. As new medications and therapies are developed for obesity, it will be important for medical practitioners to continue to report and study their cutaneous effects so that obesity can be better managed in the future.

REFERENCES

1. Fontaine K, Barofsky I. Obesity and health-related quality of life. *Obes Rev*. 2001;2(3):173-182.
2. Peeters A, O'brien PE, Laurie C, et al. Substantial intentional weight loss and mortality in the severely obese. *Ann Surg*. 2007;246(6):1028-1033.
3. Batsis JA, Zagaria AB. Addressing obesity in aging patients. *Med Clin North Am*. 2018;102(1):65-68.
4. Ryan DH, Kahan S. Guideline recommendations for obesity management. *Med Clin North Am*. 2018;102(1):49-63.
5. Dias S, Paredes S, Ribeiro L. Drugs involved in dyslipidemia and obesity treatment: focus on adipose tissue. *Int J Endocrinol*. 2018;2018:2637418.
6. Dayan SH, Schlessinger J, Beer K, et al. Efficacy and safety of ATX-101 by treatment session: pooled analysis of data from the phase 3 REFINE trials. *Aesthet Surg J*. 2018;38(9):998-1010.
7. Bourgeois P, Aeschlimann A. Drug-induced scleroderma. *Baillieres Clin Rheumatol*. 1991;5(1):13-20.
8. Hendricks EJ. Off-label drugs for weight management. *Diabetes Metab Syndr Obes*. 2017;10:223-234.
9. Igel LI, Sinha A, Saunders KH, Apovian CM, Vojta D, Aronne LJ. Metformin: an old therapy that deserves a new indication for the treatment of obesity. *Curr Atheroscler Rep*. 2016;18(4):16.
10. Harborne L, Fleming R, Lyall H, Sattar N, Norman J. Metformin or antiandrogen in the treatment of hirsutism in polycystic ovary syndrome. *J Clin Endocrinol*. 2003;88(9):4116-4123.
11. Bergstrom KG. Everything old is new again: spironolactone and metformin in the treatment of acne. *J Drugs Dermatol*. 2010;9(5):569-571.
12. Badr D, Kurban M, Abbas O. Metformin in dermatology: an overview. *J Eur Acad Dermatol Venereol*. 2013;27(11):1329-1335.
13. Verdolini R, Clayton N, Smith A, Alwash N, Mannello B. Metformin for the treatment of hidradenitis suppurativa: a little help along the way. *J Eur Acad Dermatol Venerol*. 2013;27(9):1101-1108.
14. Hermanns-Le T, Hermanns JF, Pierard GE. Juvenile acanthosis nigricans and insulin resistance. *Pediatr Dermatol*. 2002;19(1):12-14.
15. Brauchli YB, Jick SS, Curtin F, Meier CR. Association between use of thiazolidinediones or other oral antidiabetics and psoriasis: a population based case-control study. *J Am Acad Dermatol*. 2008;58(3):421-429.
16. Martin MJ, Hayward R, Viros A, Marais R. Metformin accelerates the growth of $BRAF^{V600E}$-driven melanoma by upregulating VEGF-A. *Cancer Discov*. 2012;2(4):344-355.
17. Chaudhary SC, Kurundkar D, Elmets CA, Kopelovich L, Athar M. Metformin, an antidiabetic agent reduces growth of cutaneous squamous cell carcinoma by targeting mTOR signaling pathway. *Photochem Photobiol*. 2012;88(5):1149-1156.
18. Klapholz L, Leitersdorf E, Weinrauch L. Leucocytoclastic vasculitis and pneumonitis induced by metformin. *Br Med J (Clin Res Ed)*. 1986;293(6545):483.
19. Skandalis K, Spirova M, Gaitanis G, Tsartsarakis A, Bassukas ID. Drug-induced bullous pemphigoid in diabetes mellitus patients receiving dipeptidyl peptidase-IV inhibitors plus metformin. *J Eur Acad Dermatol Venerol*. 2012;26(2):249-253.
20. Azzam H, Bergman R, Friedman-Birnbaum R. Lichen planus associated with metformin therapy. *Dermatology*. 1997;194(4):376.
21. Cosentino G, Conrad AO, Uwaifo GI. Phentermine and topiramate for the management of obesity: a review. *Drug Des Devel Ther*. 2013;7:267-278.
22. Cerminara C, Seri S, Bombardieri R, Pinci M, Curatolo P. Hypohidrosis during topiramate treatment: a rare and reversible side effect. *Pediatr Neurol*. 2006;34(5):392-394.
23. Fleury V, Wayte J, Kiley M. Topiramate-induced delusional parasitosis. *J Clin Neurosci*. 2008;15(5):597-599.
24. Serrao R, Zirwas M, English JC. Palmar erythema. *Am J Clin Dermatol*. 2007;8(6):347-356.
25. Signorelli MS, Cinconze M, Nasca MR, et al. Can topiramate induce pruritus? A case report and review of literature. *CNS Neurol Disord Drug Targets*. 2015;14(3):309-312.
26. Christou GA, Kiortsis DN. The efficacy and safety of the naltrexone/bupropion combination for the treatment of obesity: an update. *Hormones (Athens)*. 2015;14(3):370-375.
27. Singh PA, Cassel KP, Moscati RM, Eckersley D. Acute generalized erythrodermic pustular psoriasis associated with bupropion/naltrexone (Contrave®). *J Emerg Med*. 2017;52(4):e111-e113.
28. Polat M, Uzun O, Ors I, Boran C. Pityriasis rosea-like drug eruption due to bupropion: a case report. *Hum Exp Toxicol*. 2014;33(12):1294-1296.
29. Cassis TB, Callen JP. Bupropion-induced subacute cutaneous lupus erythematosus. *Australas J Dermatol*. 2005;46(4):266-269.
30. McCollom RA, Elbe DH, Ritchie AH. Bupropion-induced serum sickness-like reaction. *Ann Pharmacother*. 2000;34(4):471-473.
31. Arai I, Tsuji M, Miyagawa K, Takeda H, Akiyama N, Saito S. Repeated administration of IL-31 upregulates IL-31 receptor A (IL-31RA) in dorsal root ganglia and causes severe itch-associated scratching behaviour in mice. *Exp Dermatol*. 2015;24(1):75-78.
32. Moreno Caballero B, Castro Barrio M, Blanco Andres C. Aquagenic pruritus due to use of bupropion [Spanish]. *Aten Primaria*. 2002;30(10):662-663.
33. Satyanarayana S, Kalghatgi AT, Varghese A. Atypical mycobacterial injection abscess. *Med J Armed Forces India*. 2003;59(3):246-247.

34. Park B, Kim SJ. Cooling the skin: understanding a specific cutaneous thermosensation. *J Lifestyle Med*. 2013;3(2):91.
35. Al-Badri MR, Azar ST. Effect of glucagon-like peptide-1 receptor agonists in patients with psoriasis. *Ther Adv Endocrinol Metab*. 2014;5(2):34-38.
36. Buysschaert M, Baeck M, Preumont V, et al. Improvement of psoriasis during glucagon-like peptide-1 analogue therapy in type 2 diabetes is associated with decreasing dermal gammadelta T-cell number: a prospective case-series study. *Br J Dermatol*. 2014;171(1):155-161.
37. Faurschou A, Knop FK, Thyssen JP, Zachariae C, Skov L, Vilsboll T. Improvement in psoriasis after treatment with the glucagon-like peptide-1 receptor agonist liraglutide. *Acta Diabetol*. 2014;51(1):147-150.
38. Besemer F, Verschoor AJ, Diamant M, Hoogma RP. Vesiculopustular dermatosis: an uncommon side-effect of liraglutide? *J Diabetes Complications*. 2012;26(5):458-459.
39. Kakkar AK, Dahiya N. Drug treatment of obesity: current status and future prospects. *Eur J Intern Med*. 2015;26(2):89-94.
40. Koca Kalkan I, Kalpaklioglu AF, Atasoy P, Karabulut AA. Orlistat and obesity: be aware of lichenoid drug eruption. *Eur J Dermatol*. 2011;21(3):456-457.
41. Gonzalez-Gay MA, Garcia-Porrua C, Lueiro M, Fernandez ML. Orlistat-induced cutaneous leukocytoclastic vasculitis. *Arthritis Rheum*. 2002;47(5):567.
42. Lazic T, Fonder M, Robinson-Bostom L, Wilkel CS, Della Torre L. Orlistat-induced bullous leukocytoclastic vasculitis. *Cutis*. 2013;91(3):148-149.
43. Rotunda AM. Mixed-cell granulomatous panniculitis on the cheek due to injection of solution containing phosphatidylcholine and deoxycholate. *Dermatol Surg*. 2010;36(11):1782-1785.
44. Salzburg, Austria. *Complications with lipodissolve. First International Convention for Lipodissolve*. 2005.
45. Strumia R. Eating disorders and the skin. *Clin Dermatol*. 2013;31(1):80-85.
46. Hennings C, Miller J. Illicit drugs: what dermatologists need to know. *J Am Acad Dermatol*. 2013;69(1):135-142.
47. Deloach-Banta LJ. Lichenoid drug eruption: crystal methamphetamine or adulterants? *Cutis*. 1994;53(2):97-98.
48. Rosina P, Chieregato C, Miccolis D, D'Onghia FS. Psoriasis and side-effects of mesotherapy. *Int J Dermatol*. 2001;40(9):581-583.
49. Strahan JE, Cohen JL, Chorny JA. Granuloma annulare as a complication of mesotherapy: a case report. *Dermatol Surg*. 2008;34(6):836-838.
50. Hendricks EJ, Greenway FL, Westman EC, Gupta AK. Blood pressure and heart rate effects, weight loss and maintenance during long-term phentermine pharmacotherapy for obesity. *Obesity (Silver Spring)*. 2011;19(12):2351-2360.
51. Naltrexone + bupropion (Mysimba). Too risky for only modest weight loss. *Prescrire Int*. 2015;24(164):229-233.
52. Ladenheim EE. Liraglutide and obesity: a review of the data so far. *Drug Des Devel Ther*. 2015;9:1867-1875.
53. Fleming JW, McClendon KS, Riche DM. New obesity agents: lorcaserin and phentermine/topiramate. *Ann Pharmacother*. 2013;47(7-8):1007-1016.
54. Brashier DB, Sharma A, Dahiya N, Singh S, Khadka A. Lorcaserin: a novel antiobesity drug. *J Pharmacol Pharmacother*. 2014;5(2):175.
55. Estimate of bariatric surgery numbers, 2011-2016. Secondary estimate of bariatric surgery numbers, 2011-2016. https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers.
56. Vu L, Switzer NJ, De Gara C, Karmali S. Surgical interventions for obesity and metabolic disease. *Best Pract Res Clin Endocrinol Metab*. 2013;27(2):239-246.
57. Halawi A, Abiad F, Abbas O. Bariatric surgery and its effects on the skin and skin diseases. *Obes Surg*. 2013;23(3):408-413.
58. Vazquez BG, Alikhan A, Weaver AL, Wetter DA, Davis MD. Incidence of hidradenitis suppurativa and associated factors: a population-based study of Olmsted County, Minnesota. *J Invest Dermatol*. 2013;133(1):97-103.
59. Kromann CB, Ibier KS, Kristiansen VB, Jemec GB. The influence of body weight on the prevalence and severity of hidradenitis suppurativa. *Acta Derm Venereol*. 2014;94(5):553-557.
60. Gallagher C, Kirthi S, Burke T, O'Shea D, Tobin A-M. Remission of hidradenitis suppurativa after bariatric surgery. *JAAD Case Rep*. 2017;3(5):436-437.
61. Thomas C, Gordon K, Mortimer P. Rapid resolution of hidradenitis suppurativa after bariatric surgical intervention. *Clin Exp Dermatol*. 2014;39(3):315-318.
62. Golbari NM, Porter ML, Kimball AB. Response to: remission of hidradenitis suppurativa after bariatric surgery. *JAAD Case Rep*. 2018;4(3):278-279.
63. Upala S, Sanguankeo A. Effect of lifestyle weight loss intervention on disease severity in patients with psoriasis: a systematic review and meta-analysis. *Int J Obes*. 2015;39(8):1197.
64. Hossler E, Wood G, Still C, Mowad C, Maroon M. The effect of weight loss surgery on the severity of psoriasis. *Br J Dermatol*. 2013;168(3):660.
65. Maglio C, Peltonen M, Rudin A, Carlsson L. Bariatric surgery and the incidence of psoriasis and psoriatic arthritis in the Swedish obese subjects study. *Obesity*. 2017;25(12):2068-2073.
66. Farias M, Achurra P, Boza C, Vega A, de la Cruz C. Psoriasis following bariatric surgery: clinical evolution and impact on quality of life on 10 patients. *Obes Surg*. 2012;22(6):877-880.
67. Sako EY, Famenini S, Wu JJ. Bariatric surgery and psoriasis. *J Am Acad Dermatol*. 2014;70(4):774-779.
68. Hossler EW, Maroon MS, Mowad CM. Gastric bypass surgery improves psoriasis. *J Am Acad Dermatol*. 2011;65(1):198-200.
69. Egeberg A, Sørensen JA, Gislason GH, Knop FK, Skov L. Incidence and prognosis of psoriasis and psoriatic arthritis in patients undergoing bariatric surgery. *JAMA Surg*. 2017;152(4):344-349.
70. Zhang Y, Zhu C, Wen X, et al. Laparoscopic sleeve gastrectomy improves body composition and alleviates insulin resistance in obesity related acanthosis nigricans. *Lipids Health Dis*. 2017;16(1):209.
71. Bozkurt S, Coskun H, Kadioglu H, et al. Remission of ulcerated necrobiosis lipoidica diabeticorum after bariatric surgery. *Case Rep Dermatol Med*. 2013;2013:352579.
72. Shankar P, Boylan M, Sriram K. Micronutrient deficiencies after bariatric surgery. *Nutrition*. 2010;26(11):1031-1037.
73. Manzoni APDdS, Weber MB. Skin changes after bariatric surgery. *An Bras Dermatol*. 2015;90(2):157-166.
74. Dogan K, Homan J, Aarts EO, de Boer H, van Laarhoven CJ, Berends FJ. Long-term nutritional status in patients following Roux-en-Y gastric bypass surgery. *Clin Nutr*. 2018;37(2):612-617.
75. Sherf Dagan S, Goldenshluger A, Globus I, et al. Nutritional recommendations for adult bariatric surgery patients: clinical practice. *Adv Nutr*. 2017;8(2):382-394.
76. Stein J, Stier C, Raab H, Weiner R. The nutritional and pharmacological consequences of obesity surgery. *Aliment Pharmacol Ther*. 2014;40(6):582-609.

77. Rojas P, Gosch M, Basfi-Fer K, et al. Alopecia in women with severe and morbid obesity who undergo bariatric surgery. *Nutr Hosp*. 2011;26(4):856-862.
78. Fobi M, Lee H, Igwe D, et al. Gastric bypass in patients with BMI <40 but >32 without life-threatening co-morbidities: preliminary report. *Obes Surg*. 2002;12(1):52-56.
79. Dias MCG, Ribeiro AG, Scabim VM, Faintuch J, Zilberstein B, Gama-Rodrigues JJ. Dietary intake of female bariatric patients after anti-obesity gastroplasty. *Clinics*. 2006;61(2):93-98.
80. Neve HJ, Bhatti WA, Soulsby C, Kincey J, Taylor TV. Reversal of hair loss following vertical gastroplasty when treated with zinc sulphate. *Obes Surg*. 1996;6(1):63-65.
81. Pedrosa IV, Burgos MG, Souza NC, Morais CNd. Nutrition aspects in obese before and after bariatric surgery. [Portuguese] *Rev Col Bras Cir*. 2009;36(4):316-322.
82. Lie C, Liew CF, Oon HH. Alopecia and the metabolic syndrome. *Clin Dermatol*. 2018;36(1):54-61.
83. Ruiz-Tovar J, Oller I, Llavero C, et al. Hair loss in females after sleeve gastrectomy: predictive value of serum zinc and iron levels. *Am Surg*. 2014;80(5):466-471.
84. Goldberg LJ, Lenzy Y. Nutrition and hair. *Clin Dermatol*. 2010;28(4):412-419.
85. Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient—2013 update: cosponsored by American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic & Bariatric Surgery. *Surg Obes Relat Dis*. 2013;9(2):159-191.
86. Ashchyan HJ, Nelson CA, Stephen S, James WD, Micheletti RG, Rosenbach M. Neutrophilic dermatoses: pyoderma gangrenosum and other bowel- and arthritis-associated neutrophilic dermatoses. *J Am Acad Dermatol*. 2018;79(6):1009-1022.
87. Cugno M, Gualtierotti R, Meroni PL, Marzano AV. Inflammatory joint disorders and neutrophilic dermatoses: a comprehensive review. *Clin Rev Allergy Immunol*. 2018;54(2):269-281.
88. Marzano AV, Ishak RS, Colombo A, Caroli F, Crosti C. Pyoderma gangrenosum, acne and suppurative hidradenitis syndrome following bowel bypass surgery. *Dermatology*. 2012;225(3):215-219.
89. Al Dujaili Z, Karcher C, Henry M, Sadick N. Fat reduction: pathophysiology and treatment strategies. *J Am Acad Dermatol*. 2018;79(2):183-195.
90. Illouz YG. Body contouring by lipolysis: a 5-year experience with over 3000 cases. *Plast Reconstr Surg*. 1983;72(5):591-597.
91. The American Society for Aesthetic Plastic Surgery. Cosmetic Surgery National Data Bank 2017 statistics. https://surgery.org/sites/default/files/ASAPS-Stats2017.pdf.
92. Commons GW, Halperin B, Chang CC. Large-volume liposuction: a review of 631 consecutive cases over 12 years. *Plast Reconstr Surg*. 2001;108(6):1753-1763. discussion 64-7.
93. Al Dujaili Z, Karcher C, Henry M, Sadick N. Fat reduction: complications and management. *J Am Acad Dermatol*. 2018;79(2):197-205.
94. Berry MG, Davies D. Liposuction: a review of principles and techniques. *J Plast Reconstr Aesthet Surg*. 2011;64(8):985-992.
95. Dixit VV, Wagh MS. Unfavourable outcomes of liposuction and their management. *Indian J Plast Surg*. 2013;46(2):377-392.
96. Goddio AS. Skin retraction following suction lipectomy by treatment site: a study of 500 procedures in 458 selected subjects. *Plast Reconstr Surg*. 1991;87(1):66-75.
97. Bolivar de Souza Pinto E, da Silva Moia SM, Machado MN, Pereira ST. Morphohistologic analysis of fat tissue in areas treated with lipoplasty. *Aesthet Surg J*. 2002;22(6):513-518.
98. Collins PS, Moyer KE. Evidence-based practice in liposuction. *Ann Plast Surg*. 2018;80(6S Suppl 6):S403-S405.
99. Chia CT, Neinstein RM, Theodorou SJ. Evidence-based medicine: liposuction. *Plast Reconstr Surg*. 2017;139(1):267e-274e.
100. Rockson SG, Rivera KK. Estimating the population burden of lymphedema. *Ann N Y Acad Sci*. 2008;1131:147-154.
101. O'Brien BM, Khazanchi RK, Kumar PA, Dvir E, Pederson WC. Liposuction in the treatment of lymphoedema; a preliminary report. *Br J Plast Surg*. 1989;42(5):530-533.
102. Greene AK, Voss SD, Maclellan RA. Liposuction for swelling in patients with lymphedema. *N Engl J Med*. 2017;377(18):1788-1789.
103. Brorson H, Ohlin K, Olsson G, Svensson B, Svensson H. Controlled compression and liposuction treatment for lower extremity lymphedema. *Lymphology*. 2008;41(2):52-63.
104. Klein S, Fontana L, Young VL, et al. Absence of an effect of liposuction on insulin action and risk factors for coronary heart disease. *N Engl J Med*. 2004;350(25):2549-2557.
105. Esposito K, Giugliano G, Giugliano D. Metabolic effects of liposuction--yes or no? *N Engl J Med*. 2004;351(13):1354-1357. author reply 54-7.
106. Kwon H, Kim D, Kim JS. Body Fat distribution and the risk of incident metabolic syndrome: a longitudinal cohort study. *Sci Rep*. 2017;7(1):10955.
107. Matarasso A, Kim RW, Kral JG. The impact of liposuction on body fat. *Plast Reconstr Surg*. 1998;102(5):1686-1689.
108. Fagien S, McChesney P, Subramanian M, Jones DH. Prevention and management of injection-related adverse effects in facial aesthetics: considerations for ATX-101 (deoxycholic acid injection) treatment. *Dermatol Surg*. 2016;42(Suppl 1):S300-S304.
109. Jayasinghe S, Guillot T, Bissoon L, Greenway F. Mesotherapy for local fat reduction. *Obes Rev*. 2013;14(10):780-791.
110. Kim J-Y, Kwon M-S, Son J, Kang S-W, Song Y. Selective effect of phosphatidylcholine on the lysis of adipocytes. *PLoS One*. 2017;12(5):e0176722.
111. Beer K, Waibel J. Disfiguring scarring following mesotherapy-associated *Mycobacterium* cosmeticum infection. *J Drugs Dermatol*. 2009;8(4):391-393.
112. Georgesen C, Lipner SR. The development, evidence, and current use of ATX-101 for the treatment of submental fat. *J Cosmet Dermatol*. 2017;16(2):174-179.
113. Garibyan L, Sipprell WH 3rd, Jalian HR, Sakamoto FH, Avram M, Anderson RR. Three-dimensional volumetric quantification of fat loss following cryolipolysis. *Lasers Surg Med*. 2014;46(2):75-80.
114. Manstein D, Laubach H, Watanabe K, Farinelli W, Zurakowski D, Anderson RR. Selective cryolysis: a novel method of non-invasive fat removal. *Lasers Surg Med*. 2008;40(9):595-604.
115. Zelickson B, Egbert BM, Preciado J, et al. Cryolipolysis for noninvasive fat cell destruction: initial results from a pig model. *Dermatol Surg*. 2009;35(10):1462-1470.
116. Ingargiola MJ, Motakef S, Chung MT, Vasconez HC, Sasaki GH. Cryolipolysis for fat reduction and body contouring: safety and efficacy of current treatment paradigms. *Plast Reconstr Surg*. 2015;135(6):1581-1590.
117. Dierickx CC, Mazer JM, Sand M, Koenig S, Arigon V. Safety, tolerance, and patient satisfaction with noninvasive cryolipolysis. *Dermatol Surg*. 2013;39(8):1209-1216.

118. Garibyan L, Cornelissen L, Sipprell W, et al. Transient alterations of cutaneous sensory nerve function by noninvasive cryolipolysis. *J Invest Dermatol*. 2015;135(11):2623-2631.
119. Jalian HR, Avram MM, Garibyan L, Mihm MC, Anderson RR. Paradoxical adipose hyperplasia after cryolipolysis. *JAMA Dermatol*. 2014;150(3):317-319.
120. Light D, Arvanitis GM, Abramson D, Glasberg SB. Effect of weight loss after bariatric surgery on skin and the extracellular matrix. *Plast Reconstr Surg*. 2010;125(1):343-351.
121. Choo S, Marti G, Nastai M, Mallalieu J, Shermak MA. Biomechanical properties of skin in massive weight loss patients. *Obes Surg*. 2010;20(10):1422-1428.
122. Prist IH, Salles AG, de Lima TM, Modolin MLA, Gemperli R, Souza HP. Extracellular matrix remodeling derangement in ex-obese patients. *Mol Cell Biochem*. 2017;425(1-2):1-7.
123. Orpheu SC, Coltro PS, Scopel G, et al. Collagen and elastic content of abdominal skin after surgical weight loss. *Obes Surg*. 2010;20(4):480-486.
124. Klassen AF, Cano SJ, Scott A, Johnson J, Pusic AL. Satisfaction and quality-of-life issues in body contouring surgery patients: a qualitative study. *Obes Surg*. 2012;22(10):1527-1534.
125. Biorserud C, Nielsen C, Staalesen T, Elander A, Olbers T, Olsen MF. Sahlgrenska Excess Skin Questionnaire (SESQ): a reliable questionnaire to assess the experience of excessive skin after weight loss. *J Plast Surg Hand Surg*. 2013;47(1):50-59.
126. Kitzinger HB, Abayev S, Pittermann A, et al. The prevalence of body contouring surgery after gastric bypass surgery. *Obes Surg*. 2012;22(1):8-12.
127. Hasanbegovic E, Sorensen JA. Complications following body contouring surgery after massive weight loss: a meta-analysis. *J Plast Reconstr Aesthet Surg*. 2014;67(3):295-301.

Answers to CME examination

Identification No. JB1119

November 2019 issue of the Journal of the American Academy of Dermatology.

Rosen J, Darwin E, Tuchayi SM, Garibyan L, Yosipovitch G. J Am Acad Dermatol 2019;81:1059-69.

1. a
2. c