

Injectable Weight Loss Medications in Plastic Surgery: What We Know, Perioperative Considerations, and Recommendations for the Future

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Summary: Obesity is a major epidemic plaguing American society. Injectable subcutaneous medications initially designed for use in type 2 diabetes management, such as semaglutide and other glucagon-like peptide-1 receptor agonists, are rapidly gaining popularity for their effects on weight. These drugs (Ozempic, Wegovy, Saxenda, and Mounjaro) are ubiquitous on social media and are promoted by celebrities across all demographics. “Ozempic face” and “Ozempic butt” are now mainstream concepts highlighting the morphologic changes that occur with these medications. There is a paucity of literature available on the impact of these medications for plastic surgeons and their patients. As use becomes widespread, it is important for plastic surgeons to understand their indications, contraindications, appropriate perioperative management, and impact on plastic surgery procedures. (*Plast Reconstr Surg Glob Open* 2024; 12:e5516; doi: [10.1097/GOX.0000000000005516](https://doi.org/10.1097/GOX.0000000000005516); Published online 24 January 2024.)

INTRODUCTION

Obesity is a major epidemic plaguing American society, with 100.1 million (41.9%) adults and 14.7 million (19.7%) children affected.¹ Forty-four states, concentrated in the South and Midwest, have obesity rates over 30%,^{1,2} defined as body mass index (BMI) over 30.0 kg per m². Obesity is pervasive in American culture and is responsible for \$147 billion of annual health care expenditures.¹ Longstanding options for obesity management include diet and lifestyle modification, pharmacological therapy, and bariatric surgery.³

It is well known that weight gain and obesity play an integral role in obesity-related systemic and metabolic sequelae including type two diabetes mellitus (T2DM). Injectable pharmacotherapies designed to treat T2DM have become popular in the last few years, given their

secondary effects on weight loss. Semaglutide (trade names Ozempic and Wegovy, Novo Nordisk Inc., Plainsboro, N.J.) and liraglutide (trade name Saxenda, Novo Nordisk Inc., Plainsboro, N.J.) are glucagon-like peptide-1 (GLP-1) receptor agonists which act on many organ systems (Fig. 1), globally promoting weight loss physiology and significantly delaying gastric emptying.^{4,5} Tirzepatide (trade name Mounjaro, Eli Lilly and Company, Indianapolis, Ind.) is a similar compound that activates both GLP-1 and glucose-dependent insulinotropic polypeptide, with the same effects as semaglutide plus increased insulin sensitivity and satiety signaling.⁶

SOCIAL MEDIA AND INDUSTRY

Ozempic has gained popularity due to its spotlight on social media and celebrity use for weight loss. According to a national survey of over 1000 Americans (including physicians), 22% of Americans have inquired about Ozempic for weight loss from their doctors, 15% have personally used it, and 47% know someone who has used it for weight loss.⁷ Social media and celebrity endorsement are responsible for significant influence on Americans' interest in the drug, and physicians believe celebrity endorsement is leading to medication misuse, shortages, and access limitations for patients with diabetes.⁷ Millennial and Gen X women with obesity—major consumers of social media—are the demographics most likely to request Ozempic prescriptions for weight loss.

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Received for publication October 20, 2023; accepted November 3, 2023.

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DOI: [10.1097/GOX.0000000000005516](https://doi.org/10.1097/GOX.0000000000005516)

Disclosure statements are at the end of this article, following the correspondence information.

Over nine million prescriptions for these drugs were written in the last quarter of 2022 alone,⁸ and Morgan Stanley estimates the number of patients taking GLP-1 receptor agonists could reach 24 million, or nearly 7% of the United States population, by 2035.⁹ Social media is undoubtedly fueling this popularity, and it is significantly impacting major US industries (Fig. 2).¹⁰ Snack food brands are banking on continued growth despite weight loss medications threatening future sales.⁹ The \$76 billion diet industry may take a significant financial hit, given the rise of these drugs, and companies have already begun to roll out plans specific to people using weight loss injectables.¹¹ Major airlines are hopeful to save on weight-related fuel costs,¹² and insurance companies are grappling with the decision to cover these costly drugs.

US FOOD AND DRUG ADMINISTRATION APPROVAL AND PUBLISHED TRIALS

Wegovy and Saxenda are the only injectable medications regulating glucose homeostasis that are Food

Takeaways

Question: What do we know about the injectable weight loss medications popularized by the media and how they may affect plastic surgery patients and procedures?

Findings: Several injectable drugs exist that are used on and off label for weight loss. There are perioperative considerations plastic surgeons need to know regarding use of these medications and management of patients taking them.

Meaning: It is important for plastic surgeons and patients to understand how injectable weight loss drugs work, the risks associated with them, and recommendations for perioperative management.

and Drug Administration (FDA)–approved for weight loss. Ozempic and Mounjaro, on the other hand, are only FDA-approved for T2DM management. Therefore, using Ozempic and Mounjaro for weight loss constitutes an off-label, non-FDA approved use, and the drugs typically cost \$1000 to \$1200 or more per month.^{13,14}

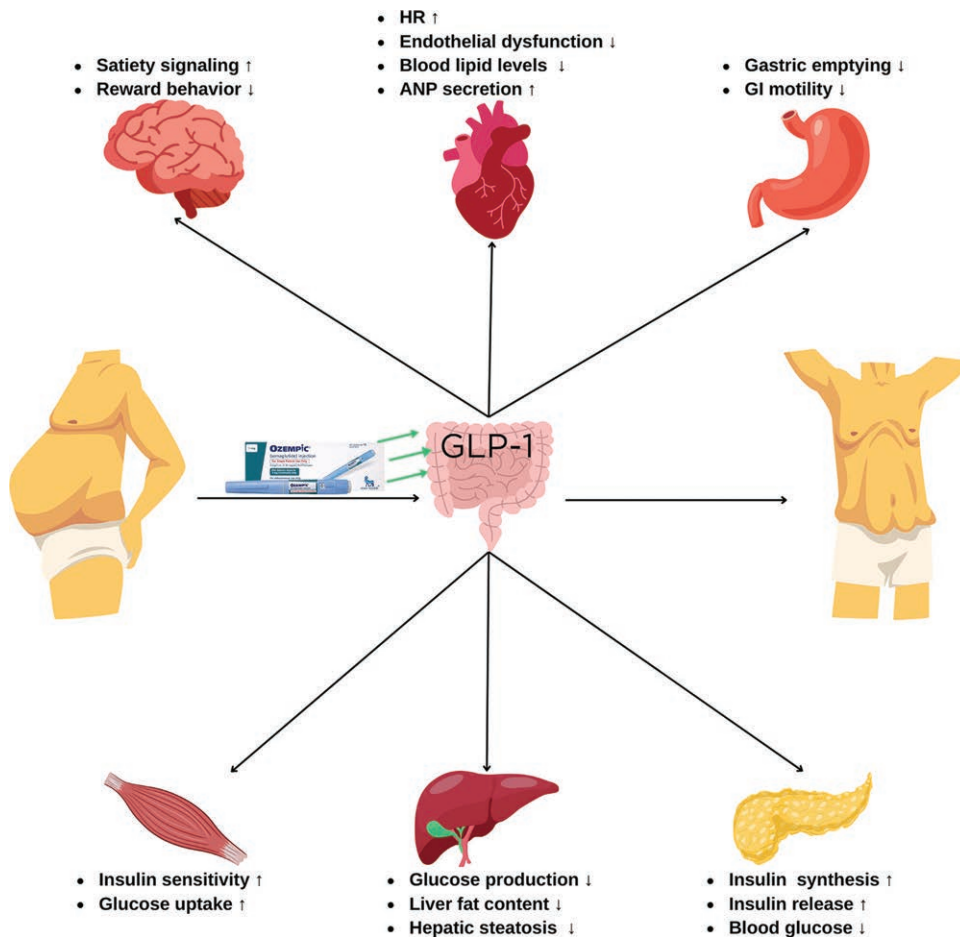


Fig. 1. Pictorial depiction of the mechanism of action of Ozempic on GLP-1 receptors. Other medications such as Wegovy, Saxenda, and Mounjaro also act on GLP-1 receptors. Up and down arrows represent an increase or decrease, respectively, in the designated end-organ function. GLP-1, glucagon-like peptide-1; HR, heart rate; ANP, atrial natriuretic peptide; GI, gastrointestinal.



Fig. 2. Example of social media post demonstrating the potential impact of drugs like Ozempic on popular culture and the economy. Credit: Morning Brew, Inc.

Wegovy is a once-weekly injectable medication indicated for weight management in conjunction with diet and lifestyle changes in adults, with a BMI of 30 kg per m² or more, or 27 kg per m² with one or more comorbidities related to being overweight. It is also approved for weight management in children aged 12 years or older, with BMI being 95th percentile or more for age and sex.¹⁵

The Semaglutide Treatment Effect in People with Obesity (STEP) trials demonstrated significant changes in body weight in nondiabetic patients with obesity after weekly treatment for 68 weeks (-14.9% versus -2.4% in the control group, $P < 0.001$ for the STEP 1 trial¹⁶; -16.0% versus -5.7% in the control group, $P < 0.004$ for the STEP 3 trial¹⁷). An extension trial evaluating patients 1 year after stopping the drug found that they regained two-thirds of the lost weight, and the cardiometabolic improvements they made at 68 weeks had reverted back to baseline metrics, demonstrating that this class of medications likely requires indefinite use for sustained results.¹⁸ Weight gain after medication cessation, in addition to the high cost of these drugs, shows that this class of medications is likely not as sustainable as more long-term options for weight management, like bariatric surgery,¹⁹ after which only one in six

patients may regain 10% or more of their presurgery body weight.²⁰

RISKS

GLP-1 receptor agonists are associated with significant contraindications, precautions, and adverse reactions (Fig. 3). They are contraindicated in patients with a personal or family history of medullary thyroid carcinoma or multiple endocrine neoplasia syndrome type 2, as well as in those who have a history of prior hypersensitivity reactions to semaglutide or any of the ingredients in the suspension.²¹ These drugs are associated with severe warnings, including risk of thyroid tumors, pancreatitis, hypersensitivity reactions, acute kidney injury, complications associated with diabetic retinopathy, and acute gallbladder pathologies.^{5,6,21} Adverse reactions include nausea, vomiting, appetite suppression, diarrhea, constipation, and abdominal pain, among others. When used in the management of DM, weekly injectable GLP-1 receptor agonists are also associated with low risk of diabetic retinopathy and associated complications, with significantly more complications seen with semaglutide use versus other medications.²² It is important for patients and plastic surgeons to understand the risk of potentially lethal hypoglycemia when GLP-1 receptor agonists are used in conjunction with other diabetic medications like sulfonylureas (ie, glyburide) or insulin. Not enough is known about the specific timing of delayed gastric emptying seen with Ozempic and Wegovy, or their impact on absorption of enteral medications, to guide concomitant medication administration.^{5,21} Similarly, there are insufficient data regarding use of these medications in pregnancy and in breastfeeding women; it is recommended that women use nonoral and/or barrier contraceptives within 4–8 weeks of using these medications and discontinue use of these medications two months before trying to conceive.

A recently published study demonstrates that GLP-1 receptor agonists affect the immune system in a myriad of ways, particularly having a potentiating effect on natural killer cells, increasing their cytotoxicity and thus making them more functional.²³ It is known that natural killer cells play a role in cancer prevention and that their function is decreased in the setting of obesity.²⁴ Although speculative, some authors suggest that restoring natural killer cell activity through medications like GLP-1 receptor agonists may affect cancer development and progression in patients affected by obesity.²³

There are currently 249 known drug interactions specific to Ozempic.²⁵ Those most relevant to plastic surgery include antibiotics (ciprofloxacin), hormonal drugs (conjugated estrogens, estradiol, progesterone), and steroids (cortisone, dexamethasone, hydrocortisone, methylprednisolone). Up-to-date drug interactions can be searched in real time at <https://www.drugs.com/drug-interactions/semaglutide,ozempic-index.html>. To our knowledge at the time of writing this article, it is not known whether injectable medications like Ozempic, Wegovy, Saxenda, and Mounjaro interact with chemotherapy or immunotherapy.

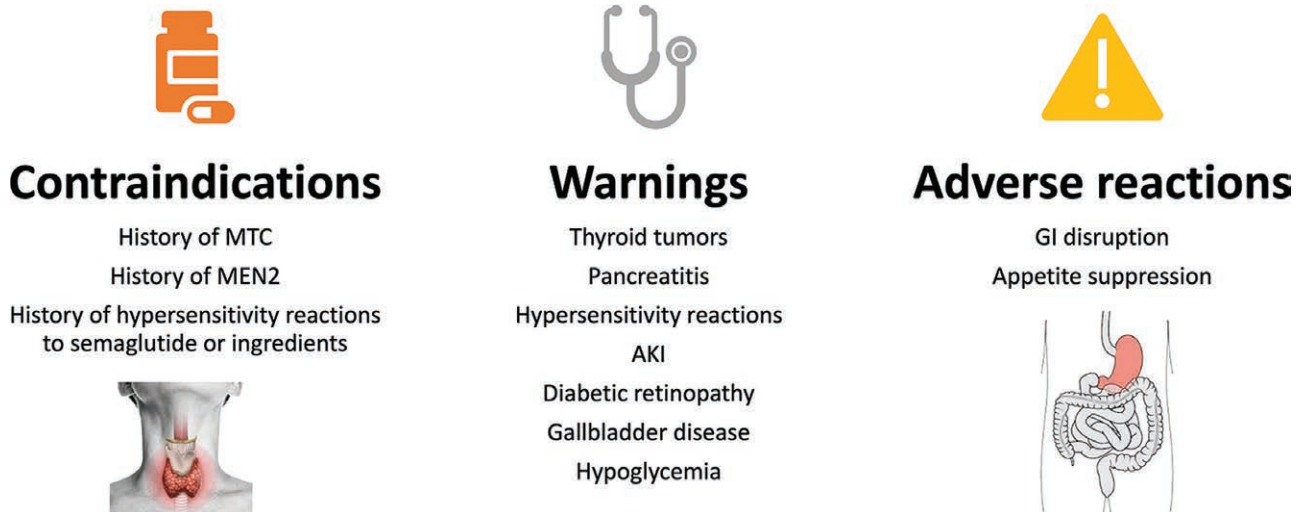


Fig. 3. Contraindications, warnings, and adverse events associated with injectable GLP-1 receptor agonists. MTC, medullary thyroid carcinoma; MEN2, multiple endocrine neoplasia type 2; AKI, acute kidney injury; GI, gastrointestinal.

PERIOPERATIVE MANAGEMENT AND CONSIDERATIONS

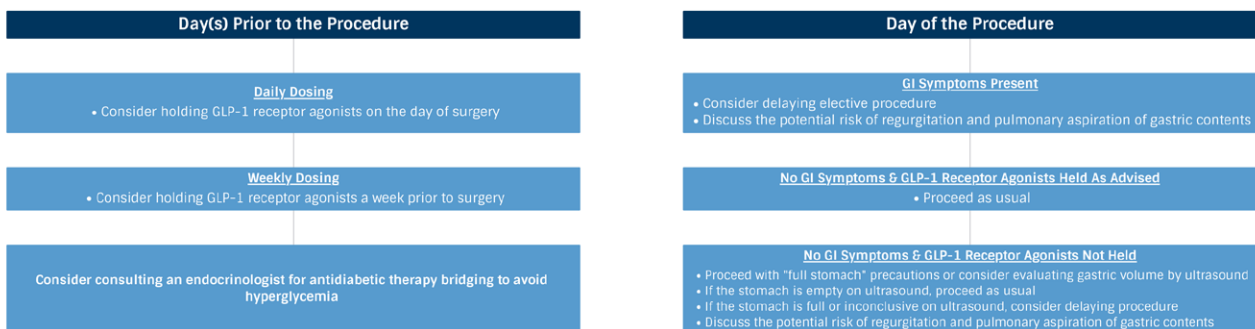
GLP-1 receptor agonism induces physiologic changes with direct implications on patient safety and surgical outcome optimization in the perioperative period. Currently, there are no evidence-based guidelines for preoperatively holding these drugs before surgery. However, the sequelae of delayed gastric emptying and decreased gastrointestinal motility likely increases the risk of general anesthesia. This has led the American Society of Anesthesiologists (ASA) to release consensus-based guidelines regarding these drugs (Fig. 4).²⁶ GLP-1 receptor agonists have been shown to lead to significantly higher residual gastric contents compared with controls undergoing esophagogastroduodenoscopy.²⁷ Previous case reports have shown residual food content in the stomachs of these patients, even after over 18 hours of fasting, leading to intraoperative pulmonary

aspiration.^{28,29} Investigators found on repeat endoscopy that the stomach was empty only after a 36-hour preprocedure liquid diet and ensuring 7 days since last medication dose.²⁹ However, there is a tachyphylactic effect over time with decreased delayed gastric emptying with longer drug use.³⁰ These data highlight the critical need for further study as more plastic surgery patients continue to be prescribed these drugs. Adherence to conservative fasting recommendations is advised along with exploring the use of adjunctive preventative measures such as preoperative gastric ultrasound.³¹

Weight loss due to GLP-1 receptor agonists is largely due to increased satiety, which often leads to consumption of significantly smaller portions. Although this may benefit a patient’s weight management efforts, if patients do not prioritize and consume sufficient protein, they face significant risk of lean mass weight loss. This leads to malnutrition, sarcopenia, and poor wound

ASA Consensus-Based Guidance

Preoperative Management of Patients On GLP-1 Receptor Agonists



There is no evidence to suggest the optimal duration of fasting for patients on GLP-1 receptor agonists. Therefore, until adequate evidence exists, following the current ASA fasting guidelines is suggested.

Fig. 4. Consensus-based guidance regarding preoperative management of patients on GLP-1 receptor agonists. GLP-1, glucagon-like peptide-1; GI, gastrointestinal.

healing.³² It is well known that poor nutritional status is associated with worse wound healing outcomes.³³ Thus, with patients presenting for consideration for surgery, it is important for the surgeon to prioritize counseling patients regarding adequate weight-based protein intake for 2–4 weeks before surgery and for another 4 weeks postoperatively for optimal perioperative optimization and outcomes.³⁴

Not all effects of semaglutide are questionable, unknown, or potentially harmful. The diabetes literature supports that GLP-1 receptor agonists have a profound positive effect of reducing risk of adverse cardiac outcomes, including cardiovascular death, stroke, and myocardial infarction ($P < 0.0001$).³⁵ These drugs are cardioprotective in nondiabetic patients as well, with demonstrated decrease in plasma lipid levels and lower blood pressure.³⁶ There is a particularly strong effect on stroke with decreased incidence of both first stroke and any stroke, attributed to the effects of semaglutide on small vessel occlusion.³⁷ These medications are also associated with decreased all-cause mortality, reduced admissions for heart failure, and decreased incidence of kidney disease and death from renal causes.³⁵ Of note, there is evidence of pharmacogenomics playing a role in the effects of GLP-1 receptor agonists,³⁸ and involving a clinical geneticist may be beneficial to help surgeons understand patient-specific risks and benefits.

Obesity is associated with an increased complication risk profile across a wide variety of plastic surgery procedures.³⁹ Weight loss from any modality, including semaglutide therapy, can optimize the outcomes of plastic surgery patients affected by obesity and help them reach preoperative BMI cutoffs.⁴⁰ Plastic surgeons should familiarize themselves with the drugs, explicitly discuss the option with patients, and make referrals to weight loss specialists in the preoperative period. Stability of weight and physical form are critical for the success of many breast and body contouring operations. Excessive weight loss or gain can drastically change results; thus, plastic surgeons must know if their patients are taking GLP-1 receptor agonists and delay surgery until a stable weight has been reached for several months. Furthermore, plastic surgeons should counsel patients about postoperative semaglutide use, as form deflation and residual skin excess could lead to unsatisfactory results. However, given the difficulties in postoperative weight loss maintenance some patients face,^{41,42} plastic surgeons may also wish to discuss GLP-1 receptor agonist therapy as an option to avoid excessive weight gain after surgery.

GLP-1 RECEPTOR AGONIST THERAPY IN PLASTIC SURGERY

There is a paucity of plastic surgery literature evaluating semaglutide and similar injectable therapies, despite a growing number of cosmetic dermatologists and plastic surgeons prescribing the drugs. Some plastic surgeons are regularly prescribing these medications to their patients to optimize them for surgery by lowering their hemoglobin

A1c values with a secondary beneficial effect of weight loss. The plastic surgery community has certainly seen many of their own patients either taking or asking questions about semaglutide. However, it is important to specifically ask patients about the use of GLP-1 receptor agonists, as many patients will not disclose medications that they deem “medically unnecessary.” Patients are actively researching and seeking out these drugs, and Google searches for semaglutide drugs has increased exponentially since 2018.⁴³ Plastic surgeons must investigate the impact GLP-1 receptor agonists are having on their patients and the field, especially as newer therapies continue to be developed.

“Ozempic face,” “Ozempic butt,” and “Ozempic body” are now mainstream terms that describe the morphological deflation of tissues due to semaglutide therapy and have been discussed at length by plastic surgeons over social media, podcasts, and blogs. This highlights an entirely new cohort of plastic surgery patients: those seeking rejuvenation after form and volume deflation from medical weight loss. Descriptions of the impact these drugs have on facial morphology have begun to emerge in the facial plastic surgery literature.

Rapid medical weight loss resulting from the use of GLP-1 receptor agonists is a global phenomenon leading to a characteristically drawn and attenuated facial appearance and accelerating the volumetric theory of facial aging.⁴⁴ Facial fat volume in key areas is critical to a youthful and rejuvenated facial aesthetic, and the sequelae of rapid medical weight loss are numerous (Fig. 5).⁴⁵ In fact, patients who undergo massive weight loss can seem up to 5 years older than similarly aged people.⁴⁶ Unfortunately, even if patients experience weight regain, the fat will likely not distribute to a pre-weight-loss state, leaving them with persistent signs of facial aging.⁴⁵

Plastic surgeons have many options at their disposal to help combat these changes to facial morphology. Dermal fillers, fat autografting, and collagen stimulators can be used to re-volumize and resurface the temple, tear trough, midface, nasolabial fold, and jowl.⁴⁷ Radiofrequency, microneedling, and laser skin tightening modalities can revitalize the skin and promote collagen and elastin production. Face and neck lifting can efface wrinkles and remove skin excess, with an understanding that superficial musculoaponeurotic system elevation may be necessary to optimize results in this population.⁴⁸ However, it seems likely that “Ozempic face” is best treated with a multimodal approach, including nutrition optimization, volumization, skin resurfacing, and surgery, including facelift, neck lift, brow lift, and others if necessary.

Similar morphologic changes in the breast and body due to semaglutide also occur. Anecdotally, these medicines can accelerate and amplify well-known changes such as postpartum breast deflation and pannus formation. These patients present to plastic surgeons with symptomatic skin excess that often hinders intimacy, socializing, exercising, fitting well into clothing, etc. Plastic surgeons who treat the massive weight loss population are familiar with these presentations and standard

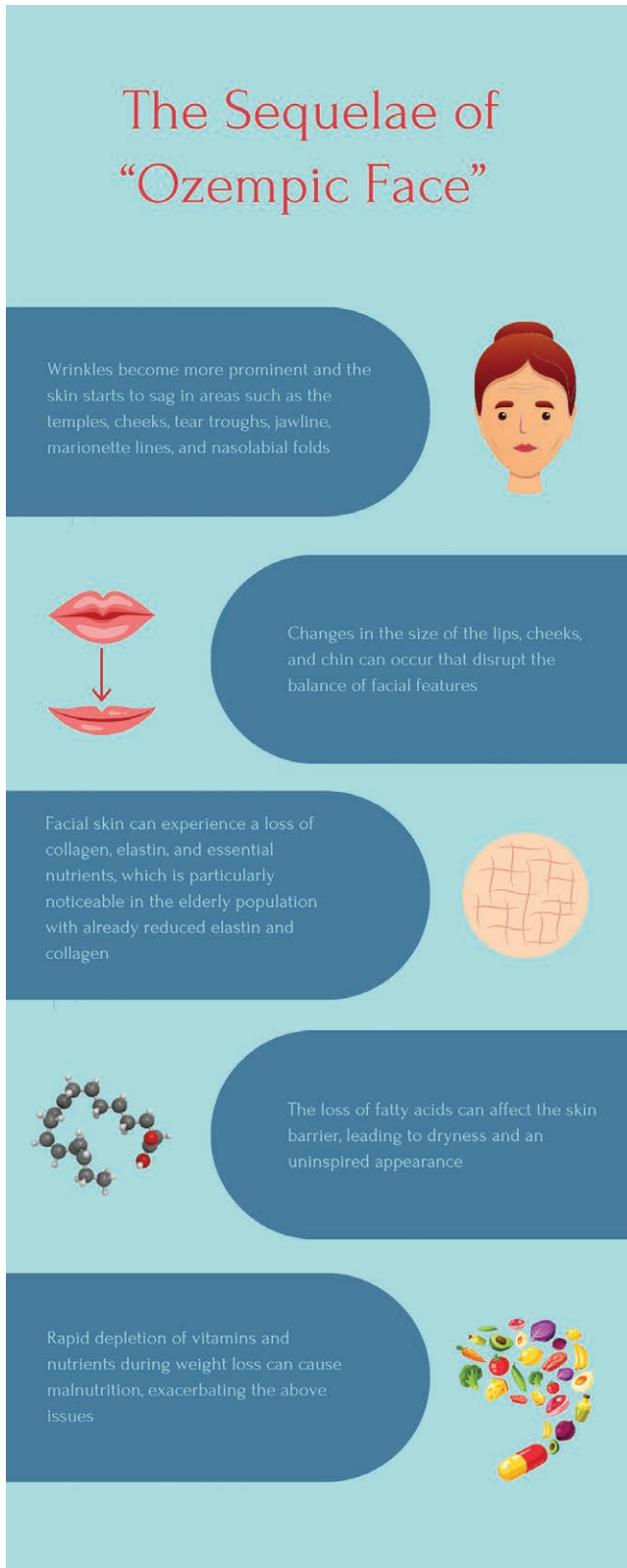


Fig. 5. Sequelae of “Ozempic face.”

breast and body contouring operations apply. Weight loss due to bariatric surgery typically plateaus around 12–18 months postoperatively, and this timing informs when

patients are ideal candidates for body contouring procedures. What remains unknown is what differences exist, if any, in patients who have lost weight due to GLP-1 receptor agonists versus surgical weight loss and when weight loss plateaus after long-term use of GLP-1 pharmacotherapy. After ensuring a several-month period of stable weight, massive medical weight loss patients may be treated like the surgical weight loss population, with an understanding that important differences may emerge as long-term data become available. For example, current evidence suggests that patients regain up to two-thirds of the weight lost upon stopping drugs like Wegovy.¹⁸ Therefore, plastic surgeons must consider abrupt rebound weight gain with medication cessation, as this may compromise long-term aesthetic results and patient satisfaction. Clearly, further study is required to address knowledge gaps and inform future evidence-based decision-making.

GLP-1 RECEPTOR AGONISTS IN OTHER SURGICAL SPECIALTIES

As in plastic surgery, there are few studies evaluating the potential effects of GLP-1 receptor agonists across all surgical specialties, highlighting the fact that we are in the infancy of our understanding of the perioperative implications of these popular drugs. Some recent articles have begun to describe the impact these therapies may be having relevant to their fields. GLP-1 receptor agonists have been shown to lead to significant weight loss in postoperative orthotopic liver transplant patients, potentially optimizing outcomes and survival.⁴⁹ Similarly, GLP-1 receptor agonists may have modest glycemic and weight benefits in renal transplantation patients.⁵⁰ In patients with short bowel syndrome after bowel resection, GLP-1 receptor agonists can significantly decrease ostomy outputs.⁵¹ Semaglutide therapy has shown efficacy as an adjunct to maintain postbariatric surgery weight loss.^{52,53} Semaglutide use during total knee arthroplasty has been suggested to decrease risk for sepsis, prosthetic joint infections, and readmissions, but may potentially increase risk for myocardial infarction, acute kidney injury, pneumonia, and hypoglycemic events.⁵⁴

RECOMMENDATIONS

- Screen all patients for the current use or potential future use of injectable weight loss medications.
- Consider referral to providers well-versed in injectable weight loss drugs (ie, medical weight loss specialists, endocrinologists) to evaluate the utility of initiating injectable weight loss medications, particularly in high BMI patients and those patients exceeding established BMI cutoffs.
- At the initial surgical consultation for body contouring procedures after medical weight loss from GLP-1 receptor agonists, consider referral to a medical weight loss specialist to guide perioperative diet optimization (particularly individualized protein consumption).
- Ensure thorough preoperative medical and relevant subspecialist clearance to optimize comorbidities before surgery.

- Consider preemptively establishing a postoperative plan for the continued use or cessation of these drugs under the guidance of a medical weight loss specialist. Regarding postoperatively resuming GLP-1 receptor agonists, be aware of the increased risk of potential complications of ileus in patients requiring opioid analgesia.
- In patients currently using injectable weight loss therapies, ensure at least a 6-month period of weight stability before any surgical intervention.
- Explicitly discuss postoperative weight regain with medication cessation and weight loss with medication continuation, potentially leading to dissatisfaction and/or the need to consider future surgery.
- Follow the ASA consensus-based guidance regarding preoperative management of patients on GLP-1 receptor agonists and consider recommending a preprocedure liquid diet and at least 18 hours of fasting.
- Consider discontinuing injectable medications at least 2 weeks preoperatively and oral medications at least 1 week preoperatively and for three weeks postoperatively.
- Obtain preoperative nutrition laboratory values according to the American College of Surgeons' recommendations and complete the Nutrition Checklist.⁵⁵
- Currently, there is no literature or anecdotal experience that suggests medical weight loss patients should be surgically treated differently than any other massive weight loss population.

CONCLUSIONS

GLP-1 receptor agonists used for weight loss and weight management—both on-label and off-label—are rapidly gaining popularity in American society, heavily influenced by social media, celebrities, and the news. Little is known about the long-term physiologic effects of these medications, and increased use among plastic surgery patients warrants further study relevant to the field. The plastic surgeon must know if their patients are using GLP-1 receptor agonists, understand the risks and benefits of these drugs, and navigate the perioperative effects they can have on plastic surgery patients.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

REFERENCES

- Centers for Disease Control and Prevention. Notice of funding opportunity: high obesity program. Available at <https://www.cdc.gov/nccdphp/dnpao/state-local-programs/hop/high-obesity-program-2023-2028.html>. Published February 23, 2023. Accessed September 20, 2023.
- Centers for Disease Control and Prevention. New adult obesity maps. Available at <https://www.cdc.gov/obesity/data/prevalence-maps.html>. Published September 21, 2023. Accessed October 6, 2023.
- Ruban A, Stoenchev K, Ashrafian H, et al. Current treatments for obesity. *Clinical medicine (London, England)*. 2019;19:205–212.
- Prescription weight-loss medicine | Saxenda (liraglutide) injection 3 mg. Available at <https://www.saxenda.com/>. Published May 2023. Accessed October 6, 2023.
- GLP-1 RA mechanism of action | Ozempic (semaglutide) injection 0.5 mg, 1 mg, or 2 mg. novoMEDLINK. Available at <https://www.novomedlink.com/diabetes/products/treatments/ozempic/about/mechanism-of-action.html>, <https://www.novomedlink.com/diabetes/products/treatments/ozempic/about/mechanism-of-action.html>. Published September 2023. Accessed September 20, 2023.
- Mounjaro (tirzepatide) | GIP and GLP-1 receptor agonist for T2D. Available at <https://www.mounjaro.com/hcp>. Published May 23, 2023. Accessed September 20, 2023.
- Ozempic in America: What's the real impact? A survey reveals details. Available at <https://www.tebra.com/theintake/medical-deep-dives/tips-and-trends/research-searching-for-ozempic>. Published March 28, 2023. Accessed September 27, 2023.
- Constantino AK. Ozempic, Wegovy drug prescriptions hit 9 million, surge 300% in under three years. CNBC. Available at <https://www.cnbc.com/2023/09/27/ozempic-wegovy-drug-prescriptions-hit-9-million.html>. Published September 27, 2023. Accessed October 14, 2023.
- Lucas A. Big food vs. big pharma: companies bet on snacking just as weight loss drugs boom. CNBC. Available at <https://www.cnbc.com/2023/10/01/kellanova-bets-on-snacking-as-ozempic-wegovy-take-off.html>. Published October 1, 2023. Accessed October 14, 2023.
- Ozempic threatens to upend whole industries. Available at <https://www.morningbrew.com/daily/stories/ozempic-threatens-to-upend-other-industries>. Published October 4, 2023. Accessed October 6, 2023.
- Petersen A, Winkler R, O'Brien SA. The \$76 billion diet industry asks: what to do about ozempic? *Wall Street J*. 2023. Available at <https://www.wsj.com/articles/ozempic-wegovy-mounjaro-weight-loss-industry-89419ecb>. Published April 10, 2023. Accessed October 14, 2023.
- Schlangenstein M. Weight-loss drugs estimated to save airlines millions. *Bloomberg*. 2023. Available at <https://www.bloomberg.com/news/articles/2023-09-29/weight-loss-drugs-ozempic-wegovy-could-reduce-airlines-costs>. Published September 29, 2023. Accessed October 14, 2023.
- Morris MS. Is Ozempic covered by insurance? *GoodRx*. Available at <https://www.goodrx.com/ozempic/is-ozempic-covered-by-insurance>. Published July 24, 2023. Accessed September 27, 2023.
- Rhinehart C. How much is mounjaro? Prices with and without insurance. *GoodRx*. Available at <https://www.goodrx.com/mounjaro/how-much-is-mounjaro-without-insurance>. Published August 23, 2023. Accessed September 27, 2023.
- Wegovy (semaglutide) injection 2.4 mg Official Physician Site. novoMEDLINK. Available at <https://www.novomedlink.com/obesity/products/treatments/wegovy.html>, <https://www.novomedlink.com/obesity/products/treatments/wegovy.html>. Published July 2023. Accessed September 20, 2023.
- Wilding JPH, Batterham RL, Calanna S, et al; STEP 1 Study Group. Once-weekly semaglutide in adults with overweight or obesity. *N Engl J Med*. 2021;384:989–1002.
- Wadden TA, Bailey TS, Billings LK, et al; STEP 3 Investigators. Effect of subcutaneous semaglutide vs placebo as an adjunct to intensive behavioral therapy on body weight in adults with overweight or obesity: the STEP 3 randomized clinical trial. *JAMA*. 2021;325:1403–1413.
- Wilding JPH, Batterham RL, Davies M, et al; STEP 1 Study Group. Weight regain and cardiometabolic effects after withdrawal of semaglutide: the STEP 1 trial extension. *Diabetes Obes Metab*. 2022;24:1553–1564.

19. O'Brien PE, Hindle A, Brennan L, et al. Long-term outcomes after bariatric surgery: a systematic review and meta-analysis of weight loss at 10 or more years for all bariatric procedures and a single-centre review of 20-year outcomes after adjustable gastric banding. *Obes Surg*. 2019;29:3–14.
20. Athanasiadis DI, Martin A, Kapsampelis P, et al. Factors associated with weight regain post-bariatric surgery: a systematic review. *Surg Endosc*. 2021;35:4069–4084.
21. Wegovy package insert. Available at <https://www.novo-pi.com/wegovy.pdf>. Published July 2023. Accessed September 26, 2023.
22. Trujillo J. Safety and tolerability of once-weekly GLP-1 receptor agonists in type 2 diabetes. *J Clin Pharm Ther*. 2020;45(Suppl 1):43–60.
23. De Barra C, Khalil M, Mat A, et al. Glucagon-like peptide-1 therapy in people with obesity restores natural killer cell metabolism and effector function. *Obesity (Silver Spring, Md.)*. 2023;31:1787–1797.
24. Katz P, Zaytoun AM, Fauci AS. Deficiency of active natural killer cells in the Chediak-Higashi syndrome Localization of the defect using a single cell cytotoxicity assay. *J Clin Invest*. 1982;69:1231–1238.
25. Ozempic drug interactions checker. Drugs.com. Available at <https://www.drugs.com/drug-interactions/semaglutide,ozempic-index.html>. Published November 2023. Accessed November 2023.
26. American Society of Anesthesiologists Consensus-Based Guidance on Preoperative Management of Patients (Adults and Children) on Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists. Available at <https://www.asahq.org/about-asa/newsroom/news-releases/2023/06/american-society-of-anesthesiologists-consensus-based-guidance-on-preoperative>. Published June 29, 2023. Accessed October 3, 2023.
27. Silveira SQ, da Silva LM, de Campos Vieira Abib A, et al. Relationship between perioperative semaglutide use and residual gastric content: a retrospective analysis of patients undergoing elective upper endoscopy. *J Clin Anesth*. 2023;87:111091.
28. Klein SR, Hobai IA. Semaglutide, delayed gastric emptying, and intraoperative pulmonary aspiration: a case report. *Can J Anaesth*. 2023;70:1394–1396.
29. Fujino E, Cobb KW, Schoenherr J, et al. Anesthesia considerations for a patient on semaglutide and delayed gastric emptying. *Cureus*. 2023;15:e42153.
30. Nauck MA, Quast DR, Wefers J, et al. GLP-1 receptor agonists in the treatment of type 2 diabetes - state-of-the-art. *Mol Metab*. 2021;46:101102.
31. Haskins SC, Kruisselbrink R, Boublik J, et al. gastric ultrasound for the regional anesthesiologist and pain specialist. *Reg Anesth Pain Med*. 2018;43:689–698.
32. Palmieri B, Vadalà M, Laurino C. Nutrition in wound healing: investigation of the molecular mechanisms, a narrative review. *J Wound Care*. 2019;28:683–693.
33. Bauer JD, Isenring E, Waterhouse M. The effectiveness of a specialised oral nutrition supplement on outcomes in patients with chronic wounds: a pragmatic randomised study. *J Hum Nutr Diet*. 2013;26:452–458.
34. Parrella N. Effects of injectable pharmacotherapies for weight loss: a weight loss specialist's perspective. Personal communication.
35. Kristensen SL, Rørth R, Jhund PS, et al. Cardiovascular, mortality, and kidney outcomes with GLP-1 receptor agonists in patients with type 2 diabetes: a systematic review and meta-analysis of cardiovascular outcome trials. *Lancet Diabetes Endocrinol*. 2019;7:776–785.
36. Ma X, Liu Z, Ilyas I, et al. GLP-1 receptor agonists (GLP-IRAs): cardiovascular actions and therapeutic potential. *Int J Biol Sci*. 2021;17:2050–2068.
37. Strain WD, Frenkel O, James MA, et al. Effects of semaglutide on stroke subtypes in type 2 diabetes: post hoc analysis of the randomized SUSTAIN 6 and PIONEER 6. *Stroke*. 2022;53:2749–2757.
38. Jakhhar K, Vaishnavi S, Kaur P, et al. Pharmacogenomics of GLP-1 receptor agonists: focus on pharmacological profile. *Eur J Pharmacol*. 2022;936:175356.
39. Bigarella LG, Ballardín AC, Couto LS, et al. The impact of obesity on plastic surgery outcomes: a systematic review and meta-analysis. *Aesthet Surg J*. 2022;42:795–807.
40. Taormina JM, Gilden AH, Iwamoto SJ. Meeting the body mass index requirement for gender-affirming surgery using antiobesity medication. *JCEM Case Rep*. 2023;1:luad067.
41. Shermak MA, Bluebond-Langner R, Chang D. Maintenance of weight loss after body contouring surgery for massive weight loss. *Plast Reconstr Surg*. 2008;121:2114–2119.
42. Greige N, Kamel GN, Leibl K, et al. Analysis of body contouring and sustained weight loss in a diverse, urban population: a 7-year retrospective review. *Plast Reconstr Surg*. 2023;151:1190–1199.
43. Han SH, Safeek R, Ockerman K, et al. Public interest in the off-label use of glucagon-like peptide 1 agonists (Ozempic) for cosmetic weight loss: a Google trends analysis. *Aesthet Surg J*. 2023;sjad211.
44. Lambros V. Facial aging: a 54-year, three-dimensional population study. *Plast Reconstr Surg*. 2020;145:921–928.
45. Humphrey CD, Lawrence AC. Implications of ozempic and other semaglutide medications for facial plastic surgeons. *Facial Plast Surg*. 2023;39:719–721.
46. Couto RA, Waltzman JT, Tadisina KK, et al. objective assessment of facial rejuvenation after massive weight loss. *Aesthetic Plast Surg*. 2015;39:847–855.
47. Tay JQ. Ozempic face: a new challenge for facial plastic surgeons. *J Plast Reconstr Aesthet Surg*. 2023;81:97–98.
48. Couto RA, Charafeddine AH, Zins JE. Facelift in Patients with Massive Weight Loss. *Clin Plast Surg*. 2019;46:559–571.
49. Chow KW, Ibrahim B, Rahal K, et al. Semaglutide is effective in achieving weight loss in liver transplant recipients. *Liver Transplant*. 2023 [E-pub ahead of print].
50. Clemens KK, Ernst J, Khan T, et al; OK TRANSPLANT Investigators. Glucagon-like peptide 1 receptor agonists in end-staged kidney disease and kidney transplantation: a narrative review. *Nutr Metab Cardiovasc Dis*. 2023;33:1111–1120.
51. Merlo FD, Aimasso U, Ossola M, et al. Effects of treatment with liraglutide early after surgical intervention on clinical outcomes in patients with short bowel syndrome: a pilot observational “Real-Life” study. *Nutrients*. 2023;15:2740.
52. Lautenbach A, Kantowski T, Wagner J, et al. Sustained weight loss with semaglutide once weekly in patients without type 2 diabetes and post-bariatric treatment failure. *Clin Obes*. 2023;13:e12593.
53. Murvelashvili N, Xie L, Schellinger JN, et al. Effectiveness of semaglutide versus liraglutide for treating post-metabolic and bariatric surgery weight recurrence. *Obes Silver Spring Md*. 2023;31:1280–1289.
54. Magruder ML, Yao VJH, Rodriguez AN, et al. Does semaglutide use decrease complications and costs following total knee arthroplasty? *J Arthroplasty*. 2023;38:2311–2315.e1.
55. Optimizing nutrition prior to surgery. ACS. Available at <https://www.facs.org/quality-programs/strong-for-surgery/clinicians/nutrition/>. Published June 27, 2018. Accessed October 14, 2023.