Management of Medical Morbidities and Risk Factors Before Surgery: Smoking, Diabetes, and Other Complicating Factors

Warren A. Ellsworth IV, M.D.¹ and Gustavo A. Colon, M.D.²

ABSTRACT

Patients interested in elective cosmetic procedures often have comorbidities and suffer from medical problems that influence the operative plan and surgical outcome. In the history and physical examination, it is important for the surgeon to identify these areas and be familiar with the associated risks in relation to the planned cosmetic procedure. Common problems that influence plastic surgery and wound healing in general include cigarette smoking, diabetes mellitus, and management of common medications. Smoking is the most common cause of preventable death in the United States today. In addition to its impact on every organ system, it has many detrimental effects on wound healing. Patients judge the results of a cosmetic procedure by symmetry, contour, and minimal scarring; each area is adversely affected by cigarette smoke. In the article "The pathophysiology of the toxins in cigarette smoke" this is outlined, and their particular influence on poor wound healing is highlighted. Techniques for smoking cessation are explained and general guidelines to optimize the outcomes of cosmetic procedures on smokers are described. Complications of diabetes mellitus are seen in heart disease, stroke, blood pressure, ocular disease, kidney failure, peripheral vascular disease, and poor wound healing. There are more than 20 million diabetics in the United States today, and plastic surgeons must be aware of the pathophysiology and impact of diabetes on wound healing and recovery after cosmetic procedures. The normal stages of wound healing are described, and the commonly accepted molecular basis for poor healing and increased infection in diabetics is discussed. The cosmetic surgeon must be aware of these added risks and make his or her patients aware preoperatively. Further, the importance of tight glycemic control in the perioperative period is explored. The question of continuation of home medications during the perioperative period is a complicated issue. Although most medications are safe to take with sips of water several hours before a procedure, some are more controversial. The use of psychotropic medication including antidepressants is gaining popularity. These medications alter the levels of neurotransmitters in the central nervous system, and the combination with anesthetic agents used in the operating room is discussed. Oral contraceptive pills and hormone replacement therapy are commonly used agents in the cosmetic surgery population. In light of their association with venous thromboembolism, recommendations for use in perioperative period are discussed.

¹Division of Plastic Surgery, Baylor College of Medicine, Houston, Texas; ²Private Practice, New Orleans, Louisiana.

Address for correspondence and reprint requests: Warren A. Ellsworth IV, M.D., Division of Plastic Surgery, Baylor College of Medicine, 1709 Dryden, Suite 1600, BCM Mail Stop: 630, Houston, TX 77030.

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The evaluation of patients interested in cosmetic surgery must include a detailed description of their preoperative medical conditions, medications, and social risk factors. These factors often influence the surgeon's plan for operation and can affect the ultimate outcome of the procedure. Common problems that influence plastic surgery and wound healing in general include cigarette smoking, diabetes mellitus, and perioperative management of common medications. In this article, we discuss these risk factors, their pathophysiology, and the impact on cosmetic surgery.

CIGARETTE SMOKING

Background

Smoking is the leading cause of preventable death in the United States, accounting for one of every five deaths annually.¹ Approximately 21% of the adult population in the United States smoke cigarettes. More than 400,000 men and woman die from a smoking-related illness every year.¹ In 2003, cigarette companies spent a shocking \$15.2 billion on advertisements and promotional expenses.² Further, the economic losses due to tobacco-related diseases continue to rise, currently nearing \$160 billion annually.¹

The number of diseases associated with cigarette smoke continues to grow. In addition to associations with many different types of cancer, every organ system is affected by cigarette smoke. Respiratory diseases including chronic obstructive pulmonary disease, emphysema, bronchitis, and pneumonia are all associated with the detrimental effects of smoke. A smoker has a much higher risk of developing cardiovascular diseases, including heart disease, hypertension, and stroke. Cerebrovascular and peripheral vascular diseases are also seen at higher rates in smokers. In addition, patients who smoke suffer from impaired wound healing and a significant increase in perioperative pulmonary complication rates. These issues raise significant concern for surgeons performing elective operations on smokers. Specifically, cosmetic procedures on active smokers should be performed with great reservation, if at all.

The spectrum of cosmetic surgery is large, and procedures often involve the face, breast, abdomen, and body contour in general. Just as smoking affects all aspects of a person's health, it certainly affects the outcome of these aesthetic procedures. Our patients judge the result of a cosmetic procedure by symmetry, good contour, and minimal scarring; each of these is adversely affected by smoking tobacco. Poor wound healing in a

cosmetic procedure can be discouraging to both patient and surgeon. Life-threatening complications or necessity for reoperation in the setting of elective cosmetic surgery can be devastating and cause significant financial strain. For these and other reasons, many plastic surgeons refuse to operate on the active smoker and often require abstinence for several weeks before an operation can be scheduled.

Pathophysiology

Tobacco smoke contains more than 4000 chemicals and toxins, many of which are caustic, carcinogenic, and lethal in high doses. Some of the most commonly named compounds found in cigarettes are acetone, ammonia, benzene, cadmium, carbon monoxide, formaldehyde, hydrogen cyanide, nicotine, lead, tar, and shellac, to name just a few.¹ The effects of these toxins are widespread and affect the function of every organ system.

The pulmonary and cardiac systems are directly affected by cigarette smoke. Nicotine and carbon monoxide cause a decrease in myocardial function, hypertension, and tachycardia.³ Further, the inhalation of smoke can directly destroy the bronchial epithelium and ciliated cells. The destruction of these protective cells allows increased uptake of the other toxins into the blood stream. The overall effect is relative tissue hypoxia and impaired wound healing.⁴

As early as 1966, Jonderko et al⁵ demonstrated that cigarette smoke decreases cutaneous blood flow. Many subsequent studies supported this belief. Goldminz and Bennett⁶ in 1991 studied over 900 flaps and grafts. In the study, a Doppler flowmeter was used to measure cutaneous microcirculation. The authors found that both chronic and new smokers demonstrated vasoconstriction after exposure to cigarette smoke, causing a decrease in cutaneous blood flow.⁶ Nicotine has been shown to cause vasoconstriction directly by stimulating release of catecholamines from the adrenal medulla and sympathetic ganglia, ultimately increasing peripheral vasoconstriction and tissue hypoxia.

Smoking-induced hypoxia is potentiated by the actions of both nicotine and carbon monoxide. Nicotine induces a balance mismatch between prostacyclin, a vasodilator, and thromboxane A₂ (TxA₂), a potent vasoconstrictor and thrombogenic agent.³ The overall effect of increased TxA₂ is a reduction of blood flow to tissue. Carbon monoxide, another component of cigarette smoke, causes a shift of the hemoglobin saturation curve. Because of its greater affinity for hemoglobin than oxygen, carbon monoxide preferentially binds hemoglobin,

preventing oxygen delivery to tissue.⁴ The hypoxic state impairs the normal wound healing process and leads to an increased risk for infection and wound dehiscence.

In the normal state, tissue hypoxia induces production of erythropoietin as well as fibrinogen. Together, they increase blood viscosity and raise the potential for thrombogenesis.⁷ Thrombus formation further inhibits blood flow in the cutaneous microvasculature, increasing risks for ischemia and tissue necrosis.

Cigarette smoke also inhibits the normal function of fibroblasts and myofibroblasts, cells imperative to normal wound healing. Wong et al⁸ demonstrated that cigarette smoke inhibits the normal migration patterns of fibroblasts. In this study, fibroblasts remained at the wound edge and failed to migrate to the center of the wound, causing excessive scar at wound edges without proper collagen formation in the wound.⁸ Fang and Svoboda⁹ used Western blot and polymerase chain reaction analysis to study the effects of nicotine on gingival myofibroblasts. The study revealed that nicotine, in high concentrations, blocked the transforming growth factor $\beta 1$ (TGF- $\beta 1$)-induced differentiation of myofibroblasts, thereby decreasing the contractile properties imperative to normal wound healing.⁹ This is the first study to show the molecular effect of nicotine on wound contracture in smokers.

The many chemicals, by-products, and carcinogens discussed here impair wound healing in smokers. The toxins cause a cascade of events leading to hypoxia, thrombogenesis, and inactivation of the inflammatory cells imperative for normal wound healing and scar maturation. These scientific studies support the already well-documented clinical effects of smoking on wound healing, infection rates, wound dehiscence, and scarring.

Effects on Cosmetic Procedures

The cosmetic procedures most affected by cigarette smoking include those that require undermining of large flaps of skin and subcutaneous tissue. The survival of these tissues is determined solely by the random-pattern blood supply consisting of the dermal-subdermal plexus.¹⁰ As discussed previously, the nicotine in cigarette smoke directly stimulates α receptors, causing vasoconstriction and poor oxygen delivery. These effects are seen most dramatically in procedures such as abdominoplasty, rhytidectomy, and breast surgery, where undermining tissue is essential to the procedure.

In 1985, Nolan et al¹¹ studied the effects of perioperative cigarette smoke exposure in 344 rats that underwent elevation of random skin flaps. The study showed a decreased survival rate of the skin flaps in rats exposed to smoke pre- and postoperatively when compared with the control group.¹¹ Craig and Rees¹² in a similar study showed the effects of smoke exposure on hamsters before and after elevation of an axial flap.

Hamsters exposed to smoke pre- and postoperatively demonstrated a 60% incidence of flap necrosis, compared with 20% flap necrosis in the preoperative exposure group.¹² This finding highlights the impact of smoke exposure immediately following an operation.

There is a significant amount of clinical support for the previously discussed experimental findings. Rees et al¹³ demonstrated that a smoker is 12.5 times more likely to suffer from skin necrosis after a face lift than a nonsmoker. In their study, more than 70% of skin sloughs were thought to be associated with cigarette smoke exposure.¹³ Breast reconstruction in the smoker has often been a point of discussion. In a retrospective review by Spear et al,¹⁴ over 200 pedicled transverse rectus abdominis myocutaneous (TRAM) reconstructions were reviewed for evaluation of wound healing problems as well as postoperative infections. The smoking group was found to have a higher incidence of wound healing difficulty as well as postoperative infections when compared with nonsmokers.¹⁴

For years there has been anecdotal evidence of increased risk of postoperative complications after abdominoplasty in smokers. Chang et al¹⁰ presented a review of the effects of smoking on plastic surgery procedures. In this discussion the authors highlighted that undermining of large skin flaps during abdominoplasty creates an area distal to the umbilicus that is based on a tenuous blood supply at best. This random blood supply is based on the dermal-subdermal plexus and can be compromised in the smoking patient.¹⁰ Chang et al and Kroll have shown in several studies that the abdominoplasty flap elevated during breast reconstruction with TRAM flap has a significantly higher incidence of flap necrosis in smokers than nonsmokers.^{15,16} In one study, the risk of abdominoplasty flap necrosis was 27.5% in smokers compared with 5.9% in nonsmokers.¹⁶ Although these observations were made in patients undergoing abdominal flap elevation for breast reconstruction, it is likely that these findings would be seen in cosmetic abdominoplasty as well. Manassa et al¹⁷ retrospectively studied 132 patients who had undergone abdominoplasty. The authors found that although the patients had been asked to refrain from smoking 2 weeks preoperatively and 2 weeks postoperatively, only 14% of patients abstained before the procedure and 41% after the procedure. In this study over 45% of the smokers suffered from wound healing problems compared with ~15% of the nonsmokers.¹⁷ This study reveals another association between smoking and poor wound healing; it highlights the patients' poor comprehension of the consequences of perioperative smoking.

In an eloquent discussion, Rohrich¹⁸ explained why he does not perform cosmetic procedures on smokers who refuse to refrain from smoking for a period of 4 weeks preoperatively. He highlights the paradox of performing cosmetic surgery on patients who desire

improvements in their appearance but refuse to comply with the one factor that will affect all aspects of their health: smoking cessation. In this discussion as well as a survey of North American plastic surgeons, Rohrich et al¹⁹ found that 60% of plastic surgeons perform less than optimal procedures on their smoking patients.¹⁹ Decreasing the amount of undermining in rhytidectomy and abdominoplasty, although less risky in the smoker, often generates a less than optimal cosmetic result.¹⁸ Plastic surgeons should understand the risks of performing cosmetic procedures on smokers; these risks should be clearly imparted to the patient. The surgeon should be prepared to accept this significant increase in perioperative morbidity or refuse to operate on the patient who is unwilling to abstain from smoking in the pre- and postoperative period.

Techniques for Cessation

Part of the duty of a physician is to counsel the patient on ways to improve the quality of his or her life. Perhaps the single most important step a smoker can take to improve his or her life is to quit smoking. In a thorough review of smoking and plastic surgery, Kreuger and Rohrich⁴ highlighted the many aids for smoking cessation, including pharmacologic nicotine replacement, non-nicotine medical agents, and behavioral and psychoanalytic treatment techniques.

Nicotine replacement therapy is an attractive method for cigarette abstention because it helps alleviate the withdrawal symptoms of irritability, anxiety, difficulty concentrating, restlessness, and increased appetite.⁴ There are several replacement strategies, including chewing gum, transdermal patch, and nasal spray. The most common replacement technique is transdermal patch, followed by nicotine-releasing chewing gum. Although there is no research to support one method of nicotine delivery over another, compliance with patch therapy is usually better because gum therapy requires constant chewing of nicotine gum. The physician should review the package inserts for dosage and tapering schedules, and patients should be aware of the side effects of the treatment of their choice.

Non-nicotine pharmacologic therapy is a new area of research. Unlike nicotine replacement strategies, these medications can safely overlap the tapering of cigarette use. The agent most widely studied and approved for use by the Food and Drug Administration is bupropion (Zyban, Wellbutrin).²⁰ Bupropion, developed as an antidepressant, increases the level of dopamine, norepinephrine, and serotonin. Although the use of bupropion as an agent for smoking cessation is widely supported, until recently there were no studies to determine the effectiveness of bupropion as an aid to stop smoking before elective procedures. Myles et al²⁰ found that smokers awaiting elective surgery were more likely

to reduce or cease cigarette smoking with bupropion compared with placebo.²⁰ The side effect profile of bupropion is generally well tolerated by patients, and the long-term possibility of complete smoking cessation with bupropion is attractive to surgeon and patient alike.

Behavioral therapy, hypnosis, psychotherapy, and self-help programs have all been studied as cessation techniques. Success rates vary greatly, but for the patient who prefers to abstain from pharmacologic agents, these techniques are viable options. The major disadvantage is the cost of such programs and the amount of time needed to dedicate to therapy or group sessions.²⁰

Concluding Thoughts

Cigarette smoking remains the number one preventable cause of morbidity and mortality in the United States today. The many toxins and chemicals in cigarette smoke affect every organ system in the human body and have a significant impact in the world of plastic surgery. Years of clinical observation and more recently scientific study have illuminated the detrimental effects of smoking on wound healing, postoperative infection, wound dehiscence, and scarring. For these reasons, plastic surgeons should remain cautious when considering cosmetic surgery on patients who remain active smokers.

The views of American plastic surgeons vary widely, and standardized requirements for the smoker interested in elective cosmetic surgery have yet to be published.¹⁹ There is no uniform opinion on when and for how long tobacco products should be discontinued preoperatively. Opinions vary from complete abstention for 1 day to 4 weeks preoperatively and from 5 days to 4 weeks postoperatively.⁴ This is an area in need of further research.

In light of the detrimental effects of cigarette smoke on every organ system, it would be ideal for the patient simply to quit smoking completely. This, however, is not always possible. Kreuger and Rohrich⁴ set guidelines dictating that patients undergoing cosmetic or elective reconstructive procedures abstain from cigarette smoking for a period of 4 weeks preoperatively and 4 weeks postoperatively. Although the evidence for this time period is anecdotal, it seems to be a conservative approach to a difficult and dangerous problem. Using these guidelines for our cosmetic patients, plastic surgeons can maximize the aesthetic outcome, minimize the patient's perioperative morbidity, and perhaps convince some to discontinue cigarette smoking altogether.

DIABETES MELLITUS

Background and Normal Wound Healing

Approximately 20.8 million Americans, 7% of the population, suffer from diabetes mellitus.²¹ Unfortunately,

one third of these people remain undiagnosed and untreated. The direct and indirect costs of diabetes in our population in 2002 were estimated as more than \$130 billion annually.²² The consequences of diabetes are seen in every organ system, and complications include heart disease, stroke, high blood pressure, blindness, kidney failure, neuropathy, peripheral vascular disease, and poor wound healing.²² Because of the widespread effects of diabetes, and particularly in light of its impact on wound healing, plastic surgeons should be familiar with the pathophysiology of diabetes mellitus and its manipulation of normal tissue repair.

Wound healing proceeds through several stages including inflammation, proliferation, and maturation. Many cells act in a coordinated response to restore the lost architecture and strength of the now wounded tissue. The first cell to respond is the platelet, which is activated by exposure to the subendothelial collagen. Once activated, the platelets help form the hemostatic plug and work to release several activating substances, including platelet-derived growth factor (PDGF), TGF- β , fibronectin, and serotonin. These factors herald the arrival of the monocytes and neutrophils to follow. Further, PDGF is significantly important as it signals the migration of fibroblasts, a central figure in the future stages of wound healing.²³

The proliferative phase begins on day 2 or 3 after initial injury. Fibronectin and PDGF help stimulate fibroblast chemotaxis and collagen production, respectively. Over a period of days to weeks, fibroblasts produce glycosaminoglycans, which undergo a series of chemical changes creating the ground substance imperative to the production of collagen.²⁴ Collagen levels rise over the next 3 weeks. In a proportionate manner, the number of fibroblasts falls during this time period, eventually achieving a balance of collagen production and degradation.²³

The final phase of wound healing, the maturation phase, typically begins on week 3 after injury. Capillaries regress from the scar, type III collagen is converted to the stronger type I, and the cross-linking of collagen accelerates as the wound works toward its new peak tensile strength. The length of the maturation phase and the ultimate strength of the wound compared with uninjured tissue are quite variable. It is known, however, that injured tissue usually reaches only ~70 to 80% of its initial strength even in the best of clinical situations.

Effect of Diabetes on Wound Healing

For years, plastic surgeons have noted delayed wound healing in their patients with diabetes mellitus. The exact mechanism for this impairment, however, is not yet completely understood. Researchers have found that hyperglycemia affects the macro- and microvasculature

and creates metabolic derangements that affect wound healing at the cellular level.

Diabetics suffer from increased rates of wound infections and breakdown.²³ Uncontrolled hyperglycemia results in impaired phagocytosis and poor bacterial killing during the inflammatory phase. The presence of bacteria in a wound impairs normal wound healing. Diabetics suffer from an accumulation of advanced glycosylation end products, which contribute to poor oxygen delivery at the capillary level.²⁵ The ultimate consequence is a hypoxic environment that further inhibits resolution of local infection. Heavy infection causes an imbalance in collagen production favoring collagenolytic activity and prolongs the inflammatory phase, preventing peripheral epithelialization and wound closure.²⁴

Algenstaedt et al²⁶ studied alterations in the microvasculature in diabetic mice. The authors used hyperglycemic and hyperinsulinemic transgenic mice and monitored the functional and morphological changes in the microvasculature. Interestingly, the studies found that the vascular density (total length of vessels per unit area) in diabetic mice was decreased by ~30% when compared with controls. The degree of microvascular loss was inversely related to blood glucose level, with a significant vessel loss in mice with blood glucose levels of 160 mg/dL or higher. This failure of small vessels could explain the impaired wound healing seen in diabetics. Further, the study showed that the functional and morphological alterations in the vasculature are seen even in the earliest stages of diabetes and hyperglycemia. The impact of this assertion argues for tight glycemic control in the perioperative period for diabetics as well as those with incidentally discovered hyperglycemia postoperatively.²⁶

Fibroblasts play a key role in tissue repair and recovery after injury. Specifically, the fibroblast produces and deposits collagen-rich matrix and releases cytokine signals that act as important growth factors in normal tissue repair.²³ Lerman et al²⁵ compared the *in vitro* behavior of fibroblasts in diabetic mice and nondiabetic mice. Dermal fibroblasts from transgenic diabetic mice were cultured in media with various glucose concentrations and compared with nondiabetic controls. The results found a 75% reduction in diabetic fibroblast migration. Further, the diabetic fibroblast production of vascular endothelial growth factor (VEGF), a growth factor essential for normal tissue repair, was sevenfold less than that of controls.²⁵ In the normal state, hypoxia causes a significant up-regulation of fibroblast migration and VEGF production; however, the diabetic fibroblasts showed no increase in either function in response to hypoxia. These findings suggest that the hyperglycemic state directly affects the fibroblasts' ability to deposit collagen and release VEGF, both processes essential to wound healing.²⁵ As noted by the authors, VEGF

replacement in diabetics is an interesting concept in need of further research.

Epidermal keratinocytes are key players in reepithelialization of the healing wound. Terashi et al²⁷ studied the effects of hyperglycemia on cultured keratinocytes in vitro. Although the exact mechanism is not clear, hyperglycemia slowed the keratinocyte proliferation and inhibited DNA synthesis and protein production.⁷ The study suggests that hyperglycemia in diabetics could cause a decrease in the life span of the keratinocyte and contribute to the ill effects of hyperglycemia on wound healing.

Impact on Cosmetic Surgery and Possible Treatment Strategies

Plastic surgeons performing cosmetic procedures on diabetic patients must understand the increased risk of infection and delayed wound healing in these patients. Years of scientific study have uncovered some of the factors leading to the clinical findings associated with diabetes mellitus, and these must be candidly discussed with our diabetic patients requesting cosmetic procedures.

The prophylactic use of antimicrobials before operative procedures is common, especially in diabetic patients. Although there is a dearth of prospective studies supporting the perioperative use of antibiotics, especially in cosmetic procedures, it is common for plastic surgeons to use antibiotics preoperatively and for several days postoperatively. In his discussion, Rohrich highlighted the many potential detrimental effects of this unsupported use of antimicrobials, including *Clostridium difficile* colitis, growing antibiotic resistance, and the added financial burden of the drug itself.²⁸ Despite lack of experimental support, diabetes remains a common indication for the use of perioperative antibiotics.²⁹ This is certainly an area in need of further research.

At this time, there is little support for any pharmacologic agents to counteract the metabolic effects of diabetes. Arguments have been made for the replacement of various growth factors deficient in these patients. Specifically, PDGF and VEGF are factors imperative for cell-cell signaling in normal wound healing. Replacement strategies, however, remain experimental at best, and at this time there is no evidentiary support for their use clinically.

The one approach that minimizes the metabolic effects of diabetes on wound healing is tight glycemic control in the perioperative period. Several of the studies discussed previously highlight the fact that functional and morphological changes contributing to impaired wound healing are seen in the earliest stages of diabetes. In fact, some of the vascular changes seen were found in hyperglycemic mice that were normal preoperatively.²⁵

This, again, highlights the importance of postoperative glycemic control in all patients.

Guyuron and Raszewski studied healing complications in six patients with a family history of diabetes without the diagnosis themselves.³⁰ The authors highlighted the importance of taking a family history and the use of the glucose tolerance test preoperatively in any patients when undiagnosed diabetes is seriously considered.³⁰

Based on the many studies discussed, it seems in the diabetic patient's best interest to check the blood glucose level postoperatively on a regular basis. Tight glycemic control should be maintained using an appropriate sliding scale as needed. Because many cosmetic patients return home on the day of surgery or shortly thereafter, it is important to impress on the patients the importance of glycemic control at home. Patients should be vigilant in checking their blood sugar and in treating hyperglycemia. Control in the inpatient setting is easier with the help of nursing staff. As a full 33% of diabetic patients remain undiagnosed, an interesting argument can be made for blood sugar monitoring in all patients postoperatively, not only diabetics. This is an area in need of further research.

COMPLICATING FACTORS

Cosmetic surgery involves many types of procedures. Some are done in the office, using only local anesthesia, whereas others require intubation, general anesthesia in the operating room, and an extended hospital stay. For the larger procedures requiring general anesthesia, plastic surgeons must complete an exhaustive preoperative evaluation of medical conditions and medications. Generally speaking, the morning of surgery is the first time the anesthesiologist interviews the patient, and if the patient was not already instructed to continue taking or stop taking the appropriate medications, it is certainly too late and the procedure might have to be abandoned.

In general, surgeons explain to the patient that he or she should not eat or drink anything after midnight the evening prior to general anesthesia. Whether or not a patient is to take his or her medications the morning of the operation is less standardized. It is generally accepted that a patient can take pills on the morning of surgery as long as they are taken with sips of water and at least 2 hours before the administration of anesthesia. Generally, it is important for the patient with medical conditions to continue taking all medications, especially for high blood pressure, asthma, and other such conditions. Certain medications such as aspirin, clopidogrel (Plavix), and warfarin (Coumadin) alter hemostasis and probably need to be discontinued for a period of time before any major surgery. For patients taking Plavix or Coumadin for cardiac conditions, preoperative medical clearance and

discussion with the patient's primary care physician are probably warranted before discontinuing the medication.

Psychotropic Medications

With the significant increase in patients taking psychotropic medications, surgeons should be familiar with the various types of drugs and have an understanding of when and whether these medications should be discontinued perioperatively. Psychiatric medications often alter the level of neurotransmitters in the central nervous system. Discontinuation of such drugs can cause serious withdrawal symptoms; however, mixing medications with general anesthesia can also cause significant drug-drug interactions. It is especially important to make note of which psychotropic medication a patient is taking preoperatively and make a plan for continued use or discontinuation prior to surgery.

Unfortunately, there are few evidence-based guidelines for the perioperative management of psychotropic medications. Commonly used medications include monoamine oxidase inhibitors (MAOIs), tricyclic antidepressants (TCAs), typical and atypical antipsychotics, selective serotonin reuptake inhibitors (SSRIs), clozapine, and lithium. The side effect profile and drug interactions of the older medications including MAOIs and TCAs are severe. MAOIs when used in combination with sympathomimetics can induce a hypertensive crisis.³¹ Traditionally, these medications were discontinued at least 21 days prior to elective surgery; however, the danger of holding these drugs is that a severe episode of depression could be precipitated in the perioperative period.³² TCAs lower a patient's seizure threshold, and reports of hypertensive crisis and seizure when they are combined with standard anesthetics have appeared in the literature.³¹ Preoperative electrocardiography is important in these patients because of the possible effects on the cardiac conduction system, including prolongation of the QT interval. Again, some recommend tapering of TCAs over 14 days prior to elective surgery and others suggest that they can safely be continued during the perioperative period.^{31,32}

Serotonergic medications including the SSRIs are commonly prescribed and, fortunately, have a less severe side effect profile than the older antidepressants. The major risk with these medications is serotonin syndrome when they are combined with other serotonergic drugs; however, this is easily avoided by using serotonin-free anesthesia.³¹ Most psychiatrists recommend continuing these medications during the perioperative period.³²

Other psychiatric medications including lithium, typical and atypical antipsychotics, and clozapine are used in a smaller subset of patients. There are no true guidelines for the continuation of these medications. Because the drug interactions and withdrawal symptoms

are serious, elective operations on patients taking these medications should probably be dealt with by a team including the patient's primary caregiver and psychiatrist as well as the surgeon. More research is needed to determine evidence-based guidelines for the perioperative management of all psychotropic medication.

Oral Contraceptive Pills and Hormone Replacement Therapy

Venous thromboembolism (VTE) affects ~1 in 1000 people every year.³³ Risk factors include age (older than 40 years), immobilization, prior VTE, obesity, major surgery, pregnancy, cancer, estrogenic medications, and inherited coagulation disorders.³⁴ As surgeons, we are unable to change many of these risk factors, such as age, and we must take standard precautions such as thromboembolism-deterrent (TED) hose, sequential compression devices (SCDs), and anticoagulation when patients will be immobilized for several days. The risk factors for VTE are additive, and it is the surgeon's duty to limit all modifiable risk factors preoperatively.

Many of the women seeking cosmetic surgery receive either oral contraceptive pills (OCPs) or hormone replacement therapy (HRT). Various landmark trials have shown the two- to fourfold increased risk of VTE in women taking estrogen-containing medications, such as the OCPs and HRT.^{35–39} Specifically, the World Health Organization published a definitive report illuminating the two- to fivefold increased risk of VTE in patients who were taking OCPs.³⁵ The Heart and Estrogen/Progestin Replacement Study (HERS) is a landmark trial that showed that postmenopausal women receiving HRT were at two to four times more likely to develop VTE than control subjects.³⁷ Since the release of these studies, the results have been reproduced and their findings confirmed.

The question plastic surgeons are faced with is whether to require patients to stop estrogen-containing medications perioperatively. Also, if we do advise discontinuing the medication, for how long should our patients remain off the pill? The answer is controversial and surgeon specific. Shiffman⁴⁰ made a convincing argument for discontinuation of estrogens around the time of cosmetic surgery. Indeed, cosmetic procedures are elective and all risks should be minimized. Complications such as pulmonary embolus can be devastating to both patient and surgeon. Further, because of the strong association of VTE and estrogens documented in the literature, plastic surgeons should at least discuss the increased risk of continuing these medications during the perioperative period. If the patient refuses to stop the estrogen because of severity of postmenopausal symptoms or concern about becoming pregnant, the patient should be well aware of the increased risk and this should be documented on the chart.⁴⁰

The time period for cessation of estrogen-containing medication is also controversial and based on empirical evidence deduced from the previously mentioned studies. Research shows that only current use of estrogen-containing medication increases the risk of VTE.³⁶ Analysis of women who had stopped taking the medication for ~4 weeks showed that they lost their increased risk for thromboembolism.^{38,39} Further, holding the medicine for 2 weeks after a major surgery involving immobilization limits the effects of the estrogen while the patient becomes more mobile and less susceptible to venous thrombus formation. Therefore, many surgeons counsel their patients to hold estrogen-containing pills for 4 weeks before and 2 weeks after major cosmetic surgery, especially patients with prolonged immobilization or multiple risk factors for VTE. The choice remains between the surgeon and his or her patient. If the procedure is short and the patient is discharged and ambulating immediately postoperatively, many surgeons would argue for the continuation of therapy. Nevertheless, both surgeon and patient should be aware of the risks of developing the serious complication of a VTE.

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