Perioperative considerations for patient safety during cosmetic surgery – preventing complications

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Maintaining patient safety in the operating room is a major concern of surgeons, hospitals and surgical facilities. Circumventing preventable complications is essential, and pressure to avoid these complications in cosmetic surgery is increasing. Traditionally, nursing and anesthesia staff have managed patient positioning and safety issues in the operating room. As the number of office-based procedures in the plastic surgeon's practice increases, understanding and implementing patient safety guidelines by the plastic surgeon is of increasing importance.

A review of the Joint Commission's Universal Protocol highlights requirements set forth to prevent perioperative complications. In the present paper, the importance of implementing these guidelines into the cosmetic surgery practice is reviewed. Key aspects of patient safety in the operating room are outlined, including patient positioning, ocular protection and other issues essential for minimization of postoperative morbidity. Additionally, as the demand for body contouring surgery in the cosmetic practice continues to increase, special attention to safety considerations specific to the obese and massive weight loss patients is mandatory.

After review of the present paper, the reader should be able to introduce the Joint Commission's Universal Protocol into their daily practice. The reader will understand key aspects of patient positioning, airway management and ocular protection in cosmetic surgery. Finally, the reader will have a better understanding of the perioperative care of unique populations including the morbidly obese, massive weight loss patients and the elderly. Attention to detail in these aspects of patient safety can help avoid unnecessary complication and significantly improve the patient's experience and surgical outcome.

Key Words: *Body contouring surgery; Cosmetic surgery; Patient safety*

Soins périopératoires et sécurité des patients durant la chirurgie esthétique : Prévention des complications

Le maintien de la sécurité des patients au bloc opératoire est une importante préoccupation des chirurgiens, des hôpitaux et des unités de chirurgie. La prévention des complications évitables est d'une importance cruciale et l'on sent une pression croissante à cet égard en chirurgie esthétique. De tout temps, le personnel en soins infirmiers et en anesthésiologie a pris en charge les questions entourant le positionnement et la sécurité des patients au bloc opératoire. À mesure que le nombre d'interventions pratiquées dans les cabinets de chirurgie esthétique augmente, il sera de plus en plus important pour les chirurgiens de bien comprendre et mettre en œuvre les lignes directrices assurant la sécurité de leurs patients.

Une revue des principales recommandations du Protocole universel de la commission mixte résume les mesures imposées pour prévenir les complications périopératoires. Dans le présent article, les auteurs renvoient l'importance de mettre ces directives en application dans le contexte de la chirurgie esthétique. Les principaux aspects de la sécurité des patients au bloc opératoire y sont énumérés, y compris le positionnement des patients, la protection oculaire et autres questions essentielles pour réduire la morbidité postopératoire. De plus, à mesure que la demande augmente pour des interventions de correction du contour corporel en chirurgie esthétique, il faudra accorder une attention toute particulière à la sécurité des patients obèses, qui doivent subir une perte de poids considérable.

Après avoir parcouru le présent article, le lecteur sera en mesure d'intégrer le Protocole universel de la commission mixte à sa pratique quotidienne; il comprendra les principes essentiels du positionnement, de l'oxygénation et de la protection oculaire des patients de chirurgie esthétique. En terminant, il comprendra mieux les soins périopératoires requis pour certaines populations particulières, notamment les patients souffrant d'obésité morbide devant subir une perte de poids considérable et les sujets âgés. En portant attention aux détails dans ces différents aspects de la sécurité des patients, des complications indues seront évitées, sans compter que l'expérience des patients et les résultats des interventions se trouveront améliorées.

As the demand for cosmetic procedures increases, plastic surgeons are charged to maintain the highest standards for patient safety. In the past years, the issue of patient safety in health care has become a major concern of the public. The Institute of Medicine's landmark article, *To Err is Human*, shares the staggering statistic that between 44,000 and 98,000 Americans die each year due to medical error (1). In this report, the authors highlight patient safety as a key area in need of improvement in hospitals today. Patient safety in the operating room is a major concern for physicians, hospitals and surgical facilities alike. Physicians have an obvious investment in the safety of their patients, and surgeons are ultimately responsible for all activity that occurs during a surgical procedure.

Hospitals and surgical facilities are reviewed by many national organizations that specifically review patient safety issues when determining accreditation status. As the trend of care for the cosmetic patient shifts to the outpatient facility, upholding the stringent guidelines held forth by the various accreditation groups becomes the surgeon's responsibility. Furthermore, the malpractice crisis in the United States only heightens the level of attention placed on safety issues in the operating room.

Due to the elective nature of cosmetic surgery, maintaining patient safety during these procedures is especially important. In the hospital setting, much of the positioning and patient preparation is completed by nurses and anesthesiology staff. Now that plastic surgeons are performing more cosmetic

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procedures in the office-based surgical setting, the importance of understanding proper safety guidelines and preoperative management of patient positioning becomes an important issue. Recent guidelines set forth by the Joint Commission, including the Universal Protocol (2), demands adherence to certain standards in operative care should the hospital remain an accredited facility.

In the present article, several key aspects of patient safety in the operating room are highlighted. A review of the Joint Commission's Universal Protocol explains perioperative requirements for accredited hospital facilities and outpatient surgical settings. Basic safety considerations are also reviewed, including attention to preoperative preparation, patient positioning, corneal protection and airway management. Issues specific to unique populations such as the elderly, obese and massive weight loss patients are discussed. Attention to these issues preoperatively may prevent complications that can become significant problems in the postoperative period.

THE 'TIME OUT'

In 2003, The American Society of Plastic Surgeons joined 50 other major medical associations endorsing the Joint Commission's Universal Protocol (2) preventing wrong site, wrong procedure and wrong person surgery. As of July 1, 2004, all accredited hospitals, ambulatory care and office-based surgery facilities are required to integrate several elements including preoperative patient identification, operative site marking and completing a 'time out' before making the first incision. This mandate comes after several sentinel events highlighted breeches in patient safety with wrong site and wrong patient surgery.

The purpose of the preoperative verification process set forth by the Universal Protocol is to ensure that the relevant documents and necessary studies are complete and accurate prior to starting a procedure. For cosmetic surgery this often includes a completed history and physical, accurate and up-to-date informed consent, and documents for clearance by medical professionals, if needed. The Protocol also highlights the importance of ensuring the presence of all implantable material needed for the procedure.

Due to an astonishingly high number of wrong site and even wrong patient surgeries, the Joint Commission now requires marking of the operative site in the preoperative holding area. Marking the patient identifies unambiguously the location of the procedure. For the plastic surgeon, this is often completed just before the procedure in the routine marking of the patient. In many cases, such as rhytidectomy, this seems unnecessary and obvious. For other procedures, such as liposuction of multiple areas, this serves as an opportunity to review with both patient and surgeon the particular areas to be addressed.

The last component of the Universal Protocol, the 'time out', acts as a final verification of the correct patient, procedure and site of operation. Furthermore, the surgeon takes this opportunity to confirm that all necessary tools and implants are present and available for the operation. The time out can be completed before or after induction, and should include the entire operative team. The guidelines explain that 'active communication' among the surgeon, anesthesia personnel and circulating nurse is required. The specific guidelines do not identify who should actually announce the time out; however,

there should be consensus among all participating members before the start of the procedure.

The number of procedures done in surgical facilities outside the hospital setting continues to rise. Also, the number of plastic surgeons using surgical facilities and office-based surgery is increasing. Optimization of patient safety in all facilities is of paramount importance for the best patient care. For these reasons, the Joint Commission created an Ambulatory Care Accreditation Program to certify these non-hospital-based facilities. Included in the requirements for certification is strict adherence to the above Universal Protocol guidelines. For these reasons, it becomes increasingly important that plastic surgeons become aware of and implement these guidelines into their everyday practices.

PATIENT POSITIONING

Positioning the patient before the start of an operation is a fundamental element to a successful procedure. Poor patient positioning can result in a more challenging procedure and can produce less satisfying results. In addition to facilitating smooth completion of the procedure, proper patient position can also prevent multiple potential postoperative morbidities. It is imperative that both the anesthesiologist and surgeon concur on position preoperatively to ensure airway protection. The team should also take into account that anesthetized patients cannot make the surgeon aware of compromised positions. Furthermore, the patient's medical comorbidities and their limitations on positioning must be considered.

Patients who undergo a procedure that requires a long operative time are at risk for pressure necrosis of skin and underlying tissue. Studies have shown that a pressure of just 70 mmHg applied for a period of 2 h or longer can result in irreversible tissue ischemia (3). Areas especially susceptible include the skin over the forehead, iliac crests and bony prominences on the arms and legs (3). Foam 'egg crates' or similar foam sponges placed over these areas and over the heels in the supine patient can help decrease the risk of injury. Also, periodic elevation of the area during the procedure allows for a greater amount of blood flow.

Peripheral nerve injury is usually a preventable complication of poor patient positioning. Nerves are injured by one of two mechanisms: stretch or compression (3). If the nerve is pulled between two fixed points, stretch injury occurs. Compression injury is largely due to loss of protective muscle tone and pressure between two fixed points. The final result is the same: nerve ischemia due to poor blood flow (4). While patients who are not sedated feel the effects of nerve ischemia and adjust body position, the anesthetized patient is unable to sense or respond to such signs.

There are three degrees of nerve injury. The first is neuropraxia, which carries the best prognosis. Neuropraxia is a response to compression with only slight evidence of demyelination and no axonal degeneration. Full recovery is expected within six weeks without residual function loss (4). The second level of nerve injury is axonotmesis, which occurs when there is destruction of the axons within a nerve sheath that remains intact (3). The distal axons degenerate and the proximal axons use the intact nerve sheath to guide regeneration at a rate of 1 mm per day. Function is initially lost but can return over the period of months to a year, depending on the length of the

nerve (4). The final and most severe nerve injury is neurotmesis, which results in disruption of axon, sheath and connective tissue covering. Degeneration of the distal axon occurs, but nerve recovery and regeneration is less likely (4). Painful neuromas can develop due to disorganized axonal regeneration. Surgical intervention with resection of nerve endings and reapproximation may help regain function.

In a study by the American Society of Anesthesiologists, nerve injury accounts for 15% of legal claims, and the most commonly injured nerves include the brachial plexus, ulnar nerve and radial nerve (4,5). These injuries are usually not permanent, but even temporary loss of the brachial plexus is an unacceptable outcome for some patients after an elective cosmetic procedure.

The brachial plexus and its branches

Brachial plexus injury is a well-documented complication of long procedures when arms are at right angles to the body or hyperextended. Akinbingol et al (6) report a case of an obese woman who underwent bilateral reduction mammoplasty, abdominoplasty and liposuction with postoperative brachial plexus denervation bilaterally. The patient slowly regained motor and sensory function over several months. The brachial plexus injury is due to stretch between the coracoid process and head of the humerus. This stretch is seen at 90 degrees of arm abduction and is worsened as the arm becomes more hyperextended (3). Plastic surgeons should be aware of this complication, as it is quite common in breast surgery to keep a patient's arms in the abducted position. Surgeons should be especially concerned in obese patients because the tension applied to the plexus can be larger at a lesser degree of abduction due to the large arm circumference (6). In these patients, abduction should be limited to 80 degrees or less to prevent injury (6). Flexion of the head with downward displacement of the shoulder can also put undue stress on the brachial plexus and should be avoided.

The ulnar and radial nerves are branches of the brachial plexus that can be injured if inappropriately positioned. The cubital tunnel compression syndrome occurs because the ulnar nerve lies superficial in the tunnel at the elbow. Some have postulated that the syndrome occurs when the arm is fixed at the patient's side or abducted with the forearm pronated. In these positions, the cubital tunnel is placed in contact with the table surface and is subject to compression injury. Supination allows the olecranon process to protect the nerve from contact with the flat surface, possibly reducing the risk of injury (4). Also, flexion of the elbow more than 90 degrees causes a decrease in the cubital tunnel size by more than 90%, possibly compressing the nerve further (4). To best avoid ulnar nerve injury, surgeons should confirm appropriate padding and avoid the above arm positions.

Like the ulnar nerve, the radial nerve lies superficial as it wraps around the proximal one-third of the humerus in the radial groove. Palsy of this nerve is less common than the ulnar, but improper padding of the arm along the arm board can predispose to compression injury and temporary functional loss. Current recommendations suggest protecting this area of the arm with soft padding and avoiding circumferential tape in the area of the proximal humerus. Studies have shown, however, that even with appropriate positioning and padding some patients will still suffer from nerve palsy (4,5). Discussing the

possibility of temporary nerve palsy preoperatively may avoid confusion or anger during the postoperative period if the complication occurs.

Surgical positions

There is a large spectrum of positions used in the operating room. In cosmetic surgery, however, the most commonly used positions include supine, prone, lateral decubitus and sitting. Supine is the most common position and allows the surgeon adequate access to the face, breast, abdomen and anterior aspects of the arms, legs and thighs. Because there is no pressure gradient above or below the heart, the physiological consequences on the cardiovascular system are minimal (3). In the supine position the surgeon should be aware of the head and cervical spine and assure that these are midline. Sudden movements of the head can place undue stress on the brachial plexus causing stretch injury. There are even reports of vertebral artery dissection after vigorous movement of the head and neck during surgery (7). Other guidelines include protection of the heels, elbows and upper arms with soft padding.

Appropriate positioning of the arms during breast surgery is important for preventing neuropraxia and for creation of breast symmetry when inspecting the patient in the seated position during the procedure. A common complicating factor is noticing that the patient's shoulders are not level when the patient is seated for inspection of symmetry during the operation. This leads to difficulty in operative technique and complicates achieving symmetry. It is common to move the patient from the supine position to the seated position several times during a cosmetic breast procedure. If the arms are not appropriately secured, they slip off the arm boards leading to neuropraxia if not corrected by anesthesia staff in a timely fashion. With the arms abducted, they should be at an angle of less than 90 degrees with elbows slightly flexed and hands in the supine position. In our institution, we commonly use foam wedges before the egg crate pads. The arms are then secured to this base using cotton web roll in a loose circumferential manner. This offers the greatest protection from palsy of the branches of the brachial plexus (4,5,7).

Plastic surgeons use the prone position more commonly than ever before. In reconstructive surgery it offers obvious access to the sacrum for pressure ulcers as well as to the gluteus and latissimus muscles for use in reconstructive efforts. In cosmetic surgery this position is useful for liposuction, circumferential body lifts, thigh lifts and buttock surgery. The prone position is usually carried out by intubation and protection of the airway in the supine position followed by transition to the prone position. Care must be given to avoid excessive pressure on the eyes, ears, nose, breasts and male genitalia (3). Basic padding requirements include using parallel gel rolls to elevate the chest off of the operative table. The gel rolls can be placed in parallel to the bed, allowing for medial placement of the breasts and genitalia (Figure 1). Other surgeons, however, prefer the gel rolls to be placed under the chest and under the pubis. Our search has found no data to support one method of chest elevation over another. The goal remains to allow space for breasts, abdomen and genitalia to rest free of pressure. Pillows or foam egg crates should be placed under the knees and ankles to avoid pressure on these bony prominences. (Figure 1).

Special attention must be given to the face and head when using the prone position. There have been several accounts of

Figure 1) Operative table for prone positioning. The patient's face is protected with a prone pillow and the chest elevated with gel rolls, allowing medial displacement of the breasts and male genitalia. All areas of bony prominence should be padded with pillows or foam egg crates

vertebral artery dissection, thrombus and stroke after a plastic surgery procedure in the prone position (8). This devastating complication occurred several days after an uneventful procedure in which the patient's head was laid on its side on a pillow to avoid pressure on the breathing tube. The position caused obstruction of the vertebral artery, dissection with thrombus formation and eventual embolus, causing stroke. To avoid this serious complication, surgeons should use standard foam prone pillows that allow for stabilization of the neck in the neutral position and direction of the endotracheal tube away from the face to avoid excessive pressure (8). Finally, attention should also be given to the arm position to avoid stretch or compression injury to the brachial plexus or its branches. Egg crate padding of the arm on standard arm boards with abduction of both the shoulder and elbow at less than 90 degrees allows for maximal protection of the nerves (3,4,8). Following these basic guidelines for the prone position allows plastic surgeons to avoid these neural and vascular complications.

Other positions used in cosmetic surgery include the lithotomy, seated and lateral decubitus, which will be discussed at length later in the paper. While each position has its own risks and benefits, the above outlined approach for protection of the head, neck and extremities from damage to the nerve and vascular structures maximizes safety in any position.

Ocular protection

Eye injury after general anesthesia is infrequent but can result in serious complication such as visual impairment. Roth et al (9) retrospectively studied a group of 60,000 patients over a four-year period and found the rate of ocular injury to be approximately 0.06% (9). The most common type of injury is corneal abrasion, and others include conjunctivitis, chemical injury and blindness.

The cornea is easily abraded due to reduced lacrimation during anesthesia (3). It is at increased risk for injury if face masks are improperly applied or if surgical drapes are manipulated while the eyes remain open (9). For these reasons, the eye lids should be closed and held closed with tape before any movement after intubation. Cosmetic surgery of the face limits the ability to protect the eyes in this way. There is little in the literature

regarding the most appropriate way to protect the eyes during face or eye surgery, but plastic corneal protectors coated with lubricant and inserted under the eyelids seem to be an effective and safe method. Many surgeons, however, are concerned that corneal protectors distort eyelid anatomy and therefore do not use them during blepharoplasty or facelift. At a minimum, eye lubricant should be used if the eyelids cannot be taped or protected otherwise. This simple intervention may help avoid corneal abrasion with suture or worse, globe trauma.

In some positions, such as prone, a significant amount of pressure can be applied to the eyes. If the pressure on the eye is greater than venous pressure, blood outflow is impeded and retinal hemorrhage is possible. If the pressure on the eye is greater than arterial pressure, inflow of oxygenated blood is stopped and retinal ischemia and blindness ensues (4). While loss of vision is rare, this complication is devastating and should be avoided at all costs. Although there are no data to prove its benefit, many plastic surgeons currently use goggles and prone pillows to protect the eyes and face from undue pressure in the prone position (8).

SPECIFIC CONSIDERATIONS

The elderly patient

The population of elderly patients seeking cosmetic procedures is increasing. Common comorbidities in this population, including osteoporosis, predisposes these patients to bone fractures even after a minimal insult such as rolling from the operating table to the stretcher (3). A minimum of four people are required to transfer a patient safely from the operating table to the stretcher. Changing positions while the patient is intubated requires even more vigilance, and special attention to the airway, extremities, genitalia and eyes is of the utmost importance.

The elderly are especially sensitive to inadvertent perioperative hypothermia. In high-risk populations such as the elderly, hypothermia triples the incidence of adverse myocardial complications and triples the incidence of surgical wound infection (10). Furthermore, the importance of continuous nasogastric suctioning during these procedures cannot be over-emphasized. Aspiration leading to pneumonia in an elderly patient can be the sentinel event leading to the rapid decline in the patient's condition during the postoperative period.

The morbidly obese patient

Dr J Howard Payne introduced the term 'morbid obesity' in the 1960s as an effort to convince insurance companies and third-party payers that surgical treatment was indicated and thus reimbursable for treating the condition of extreme obesity (11). Since that time, the rate of obesity has skyrocketed. Studies from the National Center for Health Statistics of the Centers for Disease Control and Prevention show that greater than 60% of American adults are overweight and 20% are morbidly obese (12). As this population has increased in number, so has the number of overweight patients seeking elective and cosmetic surgery. Morbidly obese patients pose another difficult challenge due to changes in normal physiology and dynamics compared with the average-sized person. While we certainly do not advocate performing elective cosmetic surgery on the morbidly obese, it is not uncommon for significantly overweight patients to present to the plastic surgeon interested in, for instance, panniculectomy or liposuction. These patients

suffer from obesity-related comorbidities, including diabetes, gastroesophageal reflux disease, sleep apnea, obesity-related hypoventilation syndrome and severe venous stasis disease (13). These related comorbidities place the obese patient at high risk for perioperative complications and strict adherence to safety guidelines in this high risk population is especially important.

Operative staff must prepare appropriate equipment and tables to accommodate extra weight. The standard operative table can safely support a 500 lb (227 kg) patient; however, attention should always be paid to the manufacturer's recommendations. Furthermore, while adequate padding is essential for all patients, the extra weight in the obese decreases the threshold of pressure required for tissue to become ischemic. Foam products may be inadequate and ineffective because of over compression due to weight, thereby providing little if any protective support. Instead, operative staff should consider heavy duty pads made of viscoelastic polymers to reduce pressure and provide support in all positions.

Anesthesia staff must be cognizant of the physiological changes associated with airway management of the obese and alterations in ventilation in various patient positions. Obese patients desaturate rapidly due to decreased functional reserve capacity, changes in compliance and sheer weight of the chest wall (14). In addition, many surgeons stress the importance of nasogastric suction in these patients. The obese patient has increased intra-abdominal pressure in addition to a predisposition to gastroesophageal reflux, placing them at high risk for aspiration (15). Use of nasogastric suction tubes during surgery and especially before extubation can decrease the risks of aspiration-related complications. Finally, positioning these patients is difficult because their extremities cannot move to the degree of slender people, and if stretched, nerve injury results more easily. In addition, standard safety straps may be too short. In such cases, 3 in (7.5 cm) silk tape can be used to effectively stabilize the patient in the appropriate position.

Perhaps the most dreaded complication that is increased in the obese population is venous thromboembolism (16). Pulmonary embolus can occur any time in the postoperative period and has even been implicated in sudden death after elective bariatric procedures as long as a month after initial surgery (17). As such, appropriate prophylaxis must be observed. The graduated compression stockings commonly used in the perioperative setting can create a constriction band at the elastic proximal-most edge. It is especially common in the obese population to suffer significant pain and constriction for a lengthy period postoperatively at this constriction point. While the complication of venous thromboembolism is certainly more concerning, special attention should be given to this area to avoid this complication during lengthy procedures. Furthermore, standard size sequential compression devices are usually poorly fit for and ineffective in the obese population; appropriately sized sequential compression stockings should be used to minimize risk of venous thromboembolism. Finally, there is no universal consensus regarding perioperative anticoagulation; however, the authors recommend serious consideration for use of low-molecular-weight heparin in this high-risk population. Please refer to the recent article by Hsu et al (18) for a comprehensive review of venous thromboembolism prophylaxis in the cosmetic patient.

As highlighted above, obesity has become increasingly common in the American population. As such, obesity continues to be extremely difficult to treat. While diet and exercise remain the mainstay of healthy treatment options for these patients, a host of other factors including genetics and cultural phenomena often complicate the effectiveness of this regimen. Bariatric surgery is the only therapy that has been shown to achieve long-term weight loss with improvement in comorbidities (19). Because of these benefits, the number of bariatric surgical procedures performed has increased 150% over the past few years (20). The increase in bariatric surgery has created a growing population of massive weight loss patients interested in body contouring surgery. These patients pose new and significant problems to the plastic surgeon. For these reasons, the following section offers an overview of the perioperative considerations for the massive weight loss patient.

BODY CONTOURING SURGERY

As studies continue to show the beneficial impact of bariatric surgery on patient health and comorbidities, indications for bariatric surgery are expected to increase (19). As such, the number of body contouring procedures will likely rise as well. Massive weight loss patients present to plastic surgeons with significantly redundant skin and subcutaneous tissue of the abdomen, thighs, buttocks, arms, back and breasts. With the number of body contouring procedures on the rise, it is especially important for surgeons to pay close attention to patient safety in this unique population. An excellent review of all aspects of care for the massive weight loss patient from a panel of experts can be found in the January 2006 supplement to *Plastic and Reconstructive Surgery* (21).

Preoperative considerations for the massive weight loss patient

Regardless of the contouring procedure to be performed, preoperative evaluation of these patients is of the utmost importance. A detailed history and physical in the office setting will highlight comorbidities that could need medical evaluation preoperatively. Based on the type of bariatric procedure performed, nutritional concerns including vitamin and electrolyte abnormalities are relatively common. For these reasons, early evaluation of laboratory data is imperative. Based on the recent recommendation of a panel of experts, routine tests including electrolyte analysis, complete blood count, albumin and prealbumin levels should be evaluated (21). Protein deficiencies and anemia are common in this population and can impair wound healing (22). Every effort should be made to diagnose and correct malnourishment before surgery if possible (23,24). Because significant blood loss can occur in these lengthy surgeries, some have suggested autologous blood donation when concern arises (22). Many patients have medical comorbidities that necessitate preoperative medical evaluation and clearance as well.

In centres with less experience with massive weight loss patients, preoperative anesthesia evaluation is beneficial. These patients often have anatomy that can complicate intubation and many experts have found fibre optic intubation useful (21). Also, the anesthesia team should be aware of change in anatomy of the gastroesophageal junction, increasing the possibility of reflux and aspiration. As discussed before, the importance of nasogastric suction and elevation of the head

whenever possible cannot be overemphasized (21). Finally, plans for intravenous access must be tailored to the scheduled procedure, and the anesthesia staff should be aware of the extremities to be operated on. In cases where all extremities are included in the operative field, a neck line can safely be used.

Operative considerations

There are many different surgical approaches to body contouring after massive weight loss. Each patient offers a unique sample of skin redundancy of varying degree over the entire body. Because of the risks of prolonged surgery, the surgeon and patient together should determine the area to be treated first. For many, the lower body, including the abdomen, flanks, lower back and buttock, causes the most concern and is generally treated first. Because operative time is a major concern for patient safety, each surgeon should be aware of his or her level of experience and speed to choose a safe operative plan. An average time for any one staged procedure should be between 6 h and 7 h in length (21). To maximize patient safety and minimize morbidity, the authors suggest that a multiprocedure, single-staged operation only be planned by the experienced body contouring surgeon and operative team.

As discussed above, appropriate patient positioning is essential to the success and safety of any procedure. In body contouring after massive weight loss, the surgeon and operative team are faced with similar problems often complicated by excessive weight and redundant skin. Generally speaking, the lower body procedures are performed in any combination of supine, prone and lateral decubitus positions. In any position, it is imperative to appropriately support bony structures and protect nerves.

In positioning patients for lower body contouring, many surgeons have found that abduction of the hips allows maximal skin resection laterally, giving the patient a more pleasing waist contour. While lower body lift procedures often benefit thigh contour irregularities, if a combined thigh lift is to be attempted, this position allows greater access for surgery. To safely accomplish this when using the prone-supine combination, spreader bars allow safe abduction of the legs and maximal tissue resection (21). As always, pressure points should be padded with foam. When the supine-lateral decubitus sequence is chosen, a wedge wrapped in sterile drapes placed between flexed knees allows for safe abduction of the hip in the lateral position (21). Regardless of whether prone-supine or supine-lateral decubitus combination is chosen, abduction of the legs can be safe and beneficial for lateral tissue resection.

The prone position can complicate safe positioning as well as patient physiology. It is important for the surgical team to pay special attention to the genitalia and breasts when the patient is prone. The male genitalia should be free from the thighs and without stress from the urinary catheter. The breasts in the postbariatric female patient are often large and ptotic. For protection and postoperative comfort, the breasts should be positioned medially and nipples protected. The prone position also alters normal respiratory physiology and thoracic pressure. Experts have highlighted the importance of careful monitoring and maintenance of the inspiratory pressure less than 30 mmHg in the massive weight loss patient (25).

The supine-lateral-lateral sequence as described by Aly et al (26) is gaining popularity among body contouring surgeons.

Many argue that this sequence maximizes abdominal contouring and the lateral decubitus position allows for maximal lateral resection (21,24). To safely achieve the transfer from supine to lateral after anterior abdominal resection, a team of several assistants is required to keep the knees and hips flexed and the legs abducted. A bean bag should be placed before the beginning of surgery and once the anterior resection is complete, an organized transfer to the lateral decubitus position can occur. In the lateral position, it is especially important to keep the patient's cervical spine in neutral position to prevent stress on the spinal cord. Because abdominoplasty is usually completed by this time, flexion at the hips and knees is important to avoid abdominal dehiscence. Usually two pillows are placed between the patient's knees for nerve protection and leg abduction. Further, an axillary support roll should be placed caudal to the axilla, resting the upper ribcage, not the axilla, on the roll (3). The dependent arm is extended less than 90 degrees and the upper arm can be rested on a Mayo stand with pillow or foam padding (3,26).

Contouring of the upper arms and breasts are often paired together in a single procedure. If this is the case, the arms should be abducted and placed on boards following the safety guidelines previously outlined. This allows access to both arms as well as the chest for breast contouring if desired. Recently, some surgeons have found that suspending the arms above the head affords an optimal position for skin and soft tissue resection without the need for an assistant to hold the arm at all times. Care must be taken to protect the wrists with padding and to limit the degree of abduction at the glenohumeral joint to protect the brachial plexus (25).

Liposuction as an adjunct treatment modality in body contouring surgery is well described in the literature (20,21,25). The timing of liposuction for the massive weight loss patient varies among plastic surgeons. Regardless, some studies have found the mortality rate associated with tumescence during liposuction to approach one in 5000 (27), demanding that the plastic surgeon be aware of appropriate and safe liposuction and tumescent technique.

The use of adrenaline-containing tumescence fluid has greatly decreased blood loss associated with liposuction (27). Large volume lipoaspirates (greater than 4 L to 5 L) have been associated with rare but devastating complications such as adrenaline and lidocaine toxicity, fluid overload, pulmonary and fat embolism. While the maximum dose of lidocaine with adrenaline is commonly cited as 7 mg/kg, the limit is dramatically increased to 35 mg/kg or more when used in tumescence fluid (28). The plasma levels remain below the toxic threshold of 5 mg/L because of immediate suctioning of some of the infiltrate as well as delayed absorption of the extremely dilute lidocaine tumescent solution. As the volume of tumescence and aspirate approaches 4 L to 5 L, the large lidocaine dose does, however, put the patient at risk for delayed toxicity. Symptoms of lidocaine toxicity are heralded by tinnitus and circumoral numbness, followed by muscle twitching, seizures and eventual coma and cardiopulmonary collapse (27). The American Society of Plastic and Reconstructive Surgeons Task Force on Lipoplasty has warned about these high volume lipoaspirates (29). Furthermore, Kenkel et al (30) have found that local tissue levels of lidocaine become greatly diminished by 4 h to 8 h, while plasma levels peak at 8 h to 16 h. This

questions the postoperative analgesic benefit of lidocaine as well as its usefulness when combining liposuction with body contouring under general anesthesia.

If large volume liposuction is to be performed alone, the surgeon should give serious consideration to removing lidocaine from the tumescence after 4 L to avoid toxicity (31). In addition, the effect of adrenaline can alter cardiac efficiency in patients with significant comorbidities. In such patients, fluid overload and pulmonary edema is certainly a concern. For these reasons and because the plasma concentration of lidocaine does not peak for 8 h 16 h postoperatively, many recommend admission with observation when the lipoaspirate approaches 3 L to 4 L (32). While the mechanical disruption of fat in such a large volume aspirate has resulted in pulmonary fat embolism before, this complication is rare but remains another reason for admission, observation and gentle hydration in these higher risk patients (32).

In many body contouring procedures, much of the body remains exposed for many hours. For this reason, core temperature should be measured throughout the procedure. As discussed previously, even a temporary drop in the core body temperature can lead to coagulopathy and triples the patient's risk of cardiac events and postoperative wound infections (10). Many surgeons now advocate warming the patient in the preoperative holding area using a forced air warming blanket. Bair Hugger Temperature Management (Arizant Healthcare Inc, USA) makes a warming blanket for use preoperatively. A prospective randomized trial published in *Lancet* showed a significant decrease in wound infections in patients who were warmed for 30 min before elective surgery (33).

In the operating room, special considerations should be made when the patient temperature falls below 35°C (21). Covering all exposed areas not actively being operated on with warm towels and forced warm air devices can help elevate the patient's temperature. If the patient's arms are not in the operative field, anecdotal evidence supports the use of occlusive plastic bags around the bilateral hands and forearms to maintain body temperature. Sterile Bair Hugger warming devices are available for use in the operative field and have also been used underneath the patient for continuous warming during these often lengthy cases. Furthermore, warmed intravenous fluids and warmed tumescent solution can be used, and the ambient temperature in the operating room can be raised. Finally, it is often forgotten, but covering the patient during position changes also helps reduce the risk of hypothermia.

Blood loss in body contouring surgery can be quite significant and often requires transfusion. Fifty per cent of massive weight loss patients are anemic preoperatively and therefore should be counselled regarding the possibility of blood transfusion or considered for preoperative autologous blood donation (21,24). In addition to an increased risk of infection, even a mild decrease in core body temperature causes coagulopathy and increases transfusion requirements (10). In addition to keeping the patient normothermic, electrocautery should be used as needed to achieve hemostasis. Some surgeons even advocate infiltrating tumescent fluid with adrenaline into the operative area before the beginning of the procedure to limit blood loss during dissection. Intraoperative

blood loss should be minimized by any method possible; however, all patients should be appropriately counselled that blood transfusion may be necessary in these lengthy procedures.

Postoperative considerations

Postoperative safety in the massive weight loss population begins with safe patient transfer from the operative bed to the in patient bed. The head of the bed should be elevated to at least 30 degrees to maximize respiratory function after extubation. Also, the surgeon's choice of thromboembolic prophylaxis should be continued until the patient is ambulating without significant pain.

Control of pain in the postoperative period allows for early ambulation and deep breathing, thereby helping prevent venous thromboembolism and pneumonia, respectively. The method of pain control varies from surgeon to surgeon. Many surgeons, however, are using pain pumps such as the On-Q Pain Relief System (I-Flow Corporation, USA). By threading catheters along the fascia in abdominal surgery, timed release of long-acting local anesthetic achieves adequate pain control. Some surgeons choose to inject bupivacaine or a long-acting local anesthetic into the deep fascia, which also can achieve appropriate pain control for a period of time. The choice of pain control is ultimately up to the surgeon; however, a thoughtful and consistent protocol can optimize pain control and enable early ambulation, thereby minimizing postoperative risks such as venous thrombosis and embolism.

With the rise in number of body contouring procedures performed yearly, we must continue to maintain heightened standards of patient safety during these procedures. While the previous discussion of perioperative safety guidelines was geared toward the massive weight loss patient, many of the key tenets highlighted are useful for any cosmetic operation on any patient.

CONCLUSIONS

Safety and patient comfort in the operating room have become increasingly important. As the pressure to avoid complications during cosmetic surgery increases, plastic surgeons should become the leading advocates for patient safety.

Observing the Universal Protocol guidelines in both the hospital and outpatient surgical facility helps engender an atmosphere of patient-centred safety and promotes thoughtful communication among the surgeon, nursing staff, anesthesia staff and patient alike. Active communication allows early identification of future problems or errors in preoperative preparation that can be alleviated before the start of surgery, thereby maximizing patient safety.

Safe and effective patient positioning can avoid frustrating nerve damage and postoperative muscle and joint pain. Furthermore, attention to the head and neck during the procedure is imperative due to the risk of devastating retinal ischemia, brachial plexus injury and damage to the vertebral vessels. Protection of vital structures from pressure damage or inadvertent injury during a cosmetic procedure is paramount, and careful attention to patient safety must remain the number one goal of the plastic surgeon. Special attention to unique issues surrounding the elderly, the obese and

the massive weight loss patient is required for safe and effective surgery. Consideration of these many patient safety issues allows for a smooth perioperative course, thereby improving the cosmetic surgery experience while optimizing patient safety.

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