Anesthetic Considerations for Abdominal Wall Reconstructive Surgery

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Abstract

Keywords

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- regional anesthesia
- intraoperative monitoring
- postoperative management

Anesthesia considerations for abdominal wall reconstruction (AWR) are numerous and depend upon the medical status of the patient and the projected procedure. Obesity, sleep apnea, hypertension, and cardiovascular disease are not uncommon in patients with abdominal wall defects; pulmonary functions and cardiac output can be affected by the surgical procedure. Patients with chronic obstructive pulmonary disease are also at a higher risk of coughing during the postoperative awakening process, which can compromise the reconstruction of the fascia. Given the increased complexity of the patients presenting for AWR, and the importance of the anesthesia for these specific procedures, it is important that surgeons are aware of the challenges that anesthesiologists face when treating these patients. Some of these challenges and their resolution are reviewed here.

Anesthesia for Abdominal Wall Reconstruction

Anesthetic considerations for abdominal wall reconstruction (AWR) are numerous and depend upon the medical status of the patient. No national registry for abdominal wall reconstruction exists; however, according to the American Society for Aesthetic Plastic Surgery's Cosmetic Surgery National Data Bank, there were 144,929 abdominoplasties performed in 2010, making it the fourth most common cosmetic procedure.¹ Historically these patients have fallen into several categories: cosmetic, status postabdominal trauma, postbariatric surgery or extreme weight loss, ventral hernia, and status postinfection/abdominal wall dehiscence. Although there are no exact numbers of patients in each of these categories, many of the anesthetic considerations are consistent across this spectrum. In particular, the higher incidence of obesity and its comorbid consequences in patients undergoing abdominoplasty entails additional anesthetic considerations.

Preoperative Evaluation

Obese patients are at a higher risk for other health complications, specifically hypertension, coronary artery disease, hyperlipidemia, diabetes, degenerative disk disease, and ob-

structive sleep apnea. Morbid obesity increases the risk of major perioperative pulmonary embolisms from DVT as well.² Patients with additional comorbidities, such as obesity and sleep apnea, have a higher risk of anesthetic complications.³ Estimates for assessing a patient's obesity include body mass index (BMI kg/m²) and hip–waist ratio, both of which are helpful predictors. Patients with a waist circumference greater than 102 cm for men and greater than 89 cm for women are at increased risk for obesity-related diseases.² Preoperatively these patients need to be evaluated and optimized medically for surgery. Hypertension is a common ailment in this patient population and should be controlled preoperatively. Pulmonary hypertension is frequent and symptoms may include exertional dyspnea, fatigue, and syncope. If the patient is either morbidly obese, or exhibits signs and symptoms of heart failure or coronary artery disease, they should have a preoperative functional cardiac evaluation, such as dobutamine stress echocardiography, to assess the extent of myocardial dysfunction and the risk of right or left ventricular failure. Additionally, patients who have undergone bariatric surgery prior to their abdominoplasty should be evaluated for vitamin and nutritional deficiencies.

Obstructive Sleep Apnea

Obesity can have deleterious effects to the upper airway. Increasing upper airway fat can promote upper airway narrowing and collapse, predisposing to obstructive sleep apnea (OSA). OSA is a sleep disorder defined as the cessation of airflow for more than 10 seconds despite respiratory effort, which occurs five or more times per hour of sleep and is associated with a decrease in arterial saturation of greater than 4%.⁴ There is a fourfold increase in OSA with each increase in standard deviation of BMI.⁵ OSA significantly impacts the anesthetic management of these patients. Patients with severe disease, classified on the apnea-hypopnea index (AHI) of greater than 30 events per hour of sleep, have a greater likelihood of severe desaturation with induction of anesthesia. Patients with OSA frequently use continuous positive airway pressure (CPAP) treatment at home to alleviate their symptoms. Patients requiring CPAP greater than 10 cm H₂O have a greater likelihood of difficult mask ventilation.³ Additionally, these patients are more sensitive to a variety of anesthetic drugs, particularly sedative/hypnotics and narcotics.

Airway Management

Obese patients present several challenges to the anesthesiologist related to airway management. Excessive amounts of airway adipose tissue can lead to difficulties with mask ventilation and intubation attempts on obese patients. A neck circumference greater than 40 cm is an independent predictor of difficult intubation.⁶ Although BMI alone is not a predictor of difficult laryngoscopy or failure to intubate, Brodsky et al demonstrated that patients with a BMI greater

than 35 have a sixfold higher risk for difficult laryngoscopy.⁷ Likewise, Lundstrom et al demonstrated in the Danish National Registry database that a BMI greater than 35 significantly increased the difficulty of intubation, and was a better predictor of airway difficulty than body weight alone.⁸ With this in mind, additional steps need to be taken to secure the airway in obese patients. Preoxygenation is critical in this patient population. In the standard patient, four deep breaths of 100% oxygen at total lung capacity provide an extra margin of safety. However, in the obese population, the expiratory reserve volume (ERV) and functional residual capacity (FRC) are markedly reduced leading to a loss in lung capacity and rapid desaturation. Therefore, preoxygenation becomes even more critical in the obese population. Several studies have demonstrated that both preoxygenating and performing intubation with the patient in the “ramp” position (►Fig. 1) increases the time before desaturation and the success of intubation.^{9,10} This tendency for rapid desaturation as well as difficult laryngoscopy requires succinct intubation techniques with high likelihoods for success. In the past, awake fiberoptic-assisted bronchoscopy was considered the technique of choice for obese patients with an anticipated difficult intubation. Although considered a very safe way to secure the airway, it is quite dependent on operator experience; not infrequently, it can be uncomfortable for the patient, mainly as a result of inadequate local anesthetic topicalization of the airway due to redundant airway tissue. New developments in airway devices now allow the anesthesia provider to intubate the patient while asleep, with equally and/or greater success and safety. One option is the laryngeal mask airway (LMA-Fastrach™; LMA North America, San Diego, CA). This allows

Figure 1 Comparison of conventional “sniff” versus “ramped” position prior to attempted laryngoscopy and intubation in morbidly obese patients (photo courtesy of Maurizio Cerida and Richard Levitan – HUP).

the anesthesiologist to place the LMA for ventilation and then intubate with a specially designed endotracheal tube (ETT) through the LMA with or without direct visualization of the vocal cords. Another airway device is the AirTraq® laryngoscope (PRODOL Meditec, Viscaya, Spain), a disposable intubating device that allows direct visualization of vocal cords while providing correct alignment for ETT placement. The AirTraq® increases both the speed and success of intubation in the morbidly obese as compared with standard laryngoscopy blades.¹¹ More recently, the GlideScope® (Verathon, Bothell, WA) videolaryngoscopy (GVL) has become the device of choice for securing the difficult airway. It is comprised of a plastic video blade connected to an external video monitor. The position of the camera at the tip of the blade requires very little extension of the head and neck to view the vocal cords, making it ideal for those patients with limited range of motion of the head or neck, while facilitating a direct view of the vocal cords allowing the operator to insert a styletted ETT.

Anesthetic Considerations

Patients with increased BMI undergoing anesthesia for abdominal wall surgery present several anesthetic challenges. Body habitus and patient positioning, as well as the planned scope of surgery, all factor into what anesthetic may be appropriate. In general, anesthesia falls into two categories: general anesthesia or regional anesthesia. General anesthesia requires the patient be fully anesthetized, with airway protection because of concomitant airway reflex obtundation. As discussed, securing the airway in an obese patient may be particularly difficult. The patient is asleep for the duration of the procedure and allowed to emerge from anesthesia once the procedure has finished. Regional anesthesia encompasses more options. A patient may have strictly regional anesthesia with no additional anesthetics, regional with mild to moderate sedation, or a patient may have general anesthesia for the procedure and then have regional anesthesia placed for postoperative pain relief.

Abdominal wall reconstruction requires that the patient be anesthetized from T4 to L1. This region can be anesthetized with neuraxial anesthesia, either by epidural or spinal anesthesia. Both provide adequate anesthesia and analgesia to the operative field and can be used alone for surgery or in conjunction with sedation or general anesthesia. The benefits of spinal anesthesia are a rapid, predictable onset of surgical anesthesia, usually within 5 to 15 minutes, and a denser block because of its placement directly in confluence with the cerebrospinal fluid (CSF). Spinal anesthesia can be accomplished as a single-shot technique or with an intrathecal catheter that can be left in place for further use during prolonged surgery.

However, if a catheter is to be used neuraxially, the more routine method would be an epidural catheter conventionally placed in the epidural space outside of the dura. Medication infused through the catheter diffuses through the dura where it has effect on the nerve roots. The density of the epidural block and field of distribution can be manipulated by the concentration and volume of local anesthetic (LA) infused in

the catheter. This is ideal for providing intraoperative as well as postoperative anesthesia to the surgical area. Additional medication can be added during the procedure, thus allowing appropriate anesthesia and analgesia no matter the length of the operation. The epidural catheter can be left in place postoperatively to provide continuous postoperative patient-controlled analgesia.

There are, however, limitations to performing spinal or epidural anesthesia in patients undergoing AWR. Although they are effective means for providing intraoperative anesthesia, caudal spread will lead to sensory and motor blockade of the lower extremities, preventing ambulation (which admittedly is not usually a major postoperative concern after AWR) as well as increase the risk of urinary retention. Likewise, local anesthetic spread rostrally can lead to loss of accessory muscles of respiration up to and including paralysis of the diaphragm, resulting in mild to profound respiratory compromise in AWR patients, who may already exhibit cardiopulmonary dysfunction from a combination of anatomic and physiologic factors such as body habitus, anatomic defects, and nutritional/metabolic deficiencies. Rostral spread of LA can also block spinal cardiac accelerator fibers, resulting in hypotension and decreases in cardiac output. Additionally, an AWR patient frequently is bedridden or immobile, placing them at risk for thromboembolic disease and necessitating the use of preventative or prophylactic anticoagulant therapy. Concomitant multiorgan dysfunction in complex AWR patients can also lead to disorders of coagulation as well. Both features would be contraindications to either epidural or spinal anesthesia because of the risk of epidural hematoma, potentially leading to compression of the spinal cord with disastrous effects. Epidural hematomas are also a consideration in these patients who are at risk for deep venous thrombosis (DVT) and pulmonary embolism (PE) and may be placed on anticoagulation immediately postoperatively. Furthermore, the tendency for these patients to be obese, as well as the anatomic nature of the abdominal wall defect itself may make patient positioning for placement of the epidural or spinal technically difficult or impossible. Therefore, spinal or epidural anesthesia may not be an option for every patient undergoing abdominal wall reconstruction.

A transversus abdominal plane (TAP) block is a compartment block that can be used as regional anesthesia in conjunction with sedation or general anesthesia. In this block, the anterior abdominal wall is anesthetized by placing a large volume of local anesthetic into the plane between the internal oblique and the transversus abdominis muscle at the triangle of Petit with ultrasound-assisted needle placement. This reliably gives anesthesia to the area under the umbilicus. With the addition of an oblique subcostal TAP block the supraumbilical region is also anesthetized, thus providing anesthesia to the entire abdominal wall.¹² This block is usually placed after the patient has been anesthetized and used for postoperative analgesia. Advantages of this type of regional anesthesia are many. Specifically, there is a reduction in postoperative narcotic requirement, which is crucial in a population at high risk for OSA. Additionally, with a TAP block, the entire abdominal wall is anesthetized, including the

musculature, reducing the need for muscle relaxants and so decreasing the risk of residual muscle paralysis postoperatively. In a series of patients undergoing major abdominal surgery, those that received the TAP block required 75% less narcotics for the first 24 hours and had average visual analog pain scores immediately after emergence from anesthesia of 1 versus 6.6 without the TAP block.¹³

There are no studies that compare different anesthetic techniques in AWR surgery; a balanced general anesthetic may prove to be the most reasonable approach. General anesthesia will provide a secured airway conduit to deliver anesthetic agents and oxygen. Ventilator modes to promote adequate oxygenation and ventilation while minimizing cardiopulmonary compromise can be achieved, such as (1) selective positive end expiratory pressure (PEEP); (2) recruitment maneuvers to minimize atelectasis, increases in hypoxic pulmonary vasoconstriction, and right ventricular strain; (3) considerations for lung protective ventilator strategies such as reduced tidal volume ventilation; and (4) minimizing peak inspiratory pressure ($< 25\text{--}30$ cm H₂O) to limit increases in abdominal compartment pressures. Narcotic administration will reduce the inhalational agent requirement while providing adequate perioperative pain relief. Finally, the control of muscle relaxation can be titrated to help the surgeon achieve ideal operating conditions and thus optimize the surgical result.

Intraoperative Considerations

If the goal of every anesthetic is to promote cardiovascular stability, then that goal is even more so in the AWR patient. To provide a sufficient level of anesthesia, the anesthesiologist must rely on monitoring that corroborates preservation of cardiopulmonary function. As such, modalities such as intra-arterial pressure monitoring, including the use of newer “noninvasive” cardiac output derived from arterial waveform data, central venous and pulmonary artery catheters (both for monitoring as well as vascular access in patients with potentially limited intravenous access), and transesophageal echocardiography may be used. These monitors assist in determining hemodynamic function while also guiding the anesthesiologist in the very important role of proper intraoperative fluid management. Abdominal compartment syndrome is a frequent comorbid condition in AWR patients and can result in significant multiorgan dysfunction, such as cardiac compromise, visceral ischemia, renal insufficiency, systemic inflammatory syndrome and/or sepsis, and respiratory impairment. The goal of the anesthesiologist must be to provide sufficient fluid replacement to prevent end organ underperfusion, while at the same time not giving too much fluid that would lead to end organ impairment resulting from increased intraabdominal pressure and the aforementioned sequelae. This degree of fine-tuning may be difficult to achieve without advanced monitoring modalities, especially in lengthy surgical procedures in patients with significant comorbidities. Recent laboratory studies support the notion that judicious fluid restriction, as advocated in other types of abdominal surgery procedures,¹⁴ in conjunction with vasopressor use (norepinephrine) may support this goal while

having no adverse effect on splanchnic and renal organ function.¹⁵ More recent studies, however, point to the difficulty of correctly judging the degree of fluid restriction by a set protocol; these authors and others show that excessive fluid restriction in abdominal surgery can be deleterious.¹⁶ From the anesthesiologist's perspective, these studies together validate the necessity of enhanced cardiovascular monitoring to individualize fluid management in each patient, not to base it on protocol alone.

The positioning of obese patients intraoperatively presents its own unique challenges. Many facilities do not have operating tables that are large enough to bear the weight or size of these patients. Additionally, padding that would be considered adequate for a standard patient is not sufficient for this population and complications can occur. Although AWR surgery is usually performed in the supine surgical position, even this can present complications for obese patients. A case report of a patient with rhabdomyolysis of gluteal muscle leading to renal failure postoperatively¹⁷ demonstrates how extra precautions need to be taken for the obese patient, particularly when the case is lengthy.

Anesthetic Effects on the Anesthetized Patient

All forms of general anesthesia have significant effects on pulmonary physiology. Induction of anesthesia decreases functional residual capacity (FRC) by 15 to 25%; when the FRC falls below the closing capacity of the lung, this leads to increases in intrapulmonary shunting and may exacerbate hypoxemia.¹⁸ This reduction in FRC may not return to baseline for up to 72 or more hours, and may render a patient who has marginal pulmonary reserve to begin as ventilator-dependent postoperatively. Obese patients have decreased chest wall and lung compliance as well, further reducing FRC. In the nonobese patient, normal tidal volume respiration occurs at lung volumes above FRC. In obese patients, however, normal tidal volume ventilation impinges on FRC, and is further exacerbated when moving from the upright to supine position and with the induction of anesthesia.¹⁹ Thus, hypoxemia and desaturation occurs far more rapidly in these patients. FRC reduction occurs within minutes of induction and regardless of the type of anesthesia or the use of muscle relaxants. The net effect is a significant increase in venous admixing, or shunt, with hypoxemia, along with reductions in FRC, both because of anesthetic agents and positioning-related changes (cephalad displacement of the diaphragm by abdominal contents, muscle relaxants, chest wall compliance, etc.). Addition of PEEP is a proven method to recruit FRC during mechanical ventilation while reducing atelectasis. PEEP of 10 cm H₂O will improve oxygenation, compliance, and recruitment in morbidly obese patients undergoing surgery with general anesthesia.²⁰ Additional factors to consider in assuming the anesthetized/supine position include increases in atelectasis either by absorption (via FiO₂ of 1.0) or compression, impaired mucociliary clearance, increases in pulmonary vascular resistance, and increased airway resistance. Additionally, volatile agents used during anesthesia profoundly blunt the patient's hypoxic drive to respiration, while narcotics used intraoperatively for pain blunt the

hypercarbic drive. Combined, these effects may inhibit the AWR surgery patient's drive to respire adequately in the immediate postoperative period. In patients undergoing AWR, these anesthesia-related effects are understandably exacerbated because of underlying factors such as obesity, increases in abdominal compartment pressures, increased sensitivities to narcotics from OSA, and preexisting pulmonary dysfunction. All of these factors provide challenges to the anesthesiologist in maintaining pulmonary function homeostasis during surgery, and, equally important, allowing the patient to resume adequate spontaneous respiratory function postoperatively.

Postoperative Management

At the conclusion of AWR surgery, the anesthesiologist must take several factors into consideration before attempting extubation. Clearly, a patient can be extubated when he or she meets accepted extubation criteria, which include an appropriate level of consciousness, sustained hand grip and head lift for more than 5 seconds (indicating appropriate reversal of muscle relaxation), negative inspiratory force of greater than 25 cm H₂O, and a respiratory rate to tidal volume ratio of less than 105, among others. In addition, the patient should be stable from a cardiac and pulmonary standpoint, and have acceptable parameters for EtCO₂ and oxygen saturation as well. However, factors such as the length of the procedure, the degree of difficulty in securing the airway in the first place, the need to provide abdominal laxity after surgical repair, and the degree of intraabdominal pressure postrepair may modify the decision to extubate immediately. Obese patients are more likely to be difficult intubations, and therefore difficult extubations.⁶ Obese patients also retain lipophilic anesthetic medications, which can delay emergence from anesthesia and lead to increased somnolence in recovery.

If the decision is to extubate immediately after surgery in the AWR patient who was a difficult intubation, the anesthesiologist will have two competing priorities. Surgical repair may necessitate minimizing and eliminating coughing and bucking at the point of extubation to prevent wound disruption and dehiscence. The difficult airway may require a very awake and alert intubated patient before ETT removal, with its attendant possibility of coughing and bucking, and surgical repair integrity. The method of deep extubation is used frequently when the anesthesiologist wants to minimize coughing and increases in abdominal pressures during emergence from anesthesia. Patients are reversed from muscle relaxants and then allowed to breathe spontaneously while deeply anesthetized, before removing the ETT and assisting with ventilation while the volatile agents are discontinued thereafter. The AWR patient, however, may have airway, body habitus, and surgical repair considerations that would preclude this approach. Therefore, other methods to blunt airway reflexes must be used. Judicious titration of narcotics in the moments prior to extubation can provide sufficient antitussive action so as to facilitate a smooth extubation, provided enhanced narcotic sensitivity in obese/OSA patients is taken into account.

Injection of 50 to 100 mg of lidocaine endotracheally will also obtund the cough reflex and allow the patient to better tolerate an ETT. To ensure airway integrity, however, the anesthesiologist may elect to place an ETT exchange catheter prior to extubation to allow for enhanced success should reintubation be required. These catheters provide a means of delivering oxygen as well, but are not effective for ventilation. As an alternative, the awakening patient may have the ETT removed and an LMA placed immediately afterward, and then allowed to awaken with this airway device in place rather than the ETT. LMAs are well tolerated in the awakening patient and provide a somewhat more secure airway than mask ventilation, with or without an oral airway.

During and immediately after extubation, measures should be undertaken to prevent and/or reduce postoperative atelectasis and clinically significant hypoxemia. As with intubation, the obese patient may benefit from extubating in the upright position rather than supine. Significant atelectasis occurs in obese patients compared with the nonobese patient in the immediate postoperative period, and positioning patients upright may mitigate this to some degree by reducing abdominal content intrusion on diaphragmatic excursion and lung volumes.²¹ Additionally, immediate application of noninvasive ventilation after extubation in select AWR patients may hasten the return of baseline lung function and limit postoperative atelectasis, hypoxemia, and desaturation, as has been demonstrated in morbidly obese patients after bariatric surgery.^{22,23}

Pain control postoperatively is a significant consideration. Narcotics blunt the hypoxic response and may lead to hypoventilation and inadequate oxygenation. The propensity of the obese population to have OSA also complicates the postoperative picture. Therefore, it is desirable to limit the use of narcotics. The use of nonnarcotic analgesia, such as Ketoralac or acetaminophen is recommended to minimize respiratory depression. Regional anesthesia, used as a sole anesthetic or as an adjunct, will also reduce the need for postoperative narcotics and help to prevent respiratory depression. If narcotics are given postoperatively—as current American Society of Anesthesiology guidelines recommend—the patient should have continuous pulse oximetry monitoring while in bed or until that time when oxygen saturation remains above 90% during sleep on room air.²⁴

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