Comorbidities and Positioning: Morbid Obesity and Multiple Trauma

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The Polytrauma Patient

Case 1 Illustration

A 29-year-old male arrives as a level 1 trauma activation after prolonged extrication at the site of a multi-vehicle collision. The patient is intubated, in a cervical collar and on a backboard with a Glasgow coma scale of 7-I on arrival. Initial vital signs show a systolic blood pressure of 75/40 and a pulse of 128 despite aggressive resuscitation with crystalloid. The primary and secondary surveys are completed. A Foley and femoral line are placed. On initial neurosurgical evaluation, the patient does not open eyes, is intubated, his pupils are equal and reactive to light, and the motor examination is asymmetrical with withdrawal of the left upper extremity and both lower extremities, and brisk localization of the right upper extremity. FAST exam shows free fluid in the abdomen. Blood pressure is stabilized after transfusion of packed red blood cells, platelets, and fresh frozen plasma, and the patient is able to be taken to the CT scanner.

Head CT reveals an acute 7 mm thick holohemispheric right-sided subdural hematoma leading to 1.2 cm of midline shift and multiple scattered cerebral contusions. Rapid review of the CT of the cervical spine shows no evidence of fracture or dislocation. Before the remaining trauma scans can be obtained the patient becomes hemodynamically unstable once again with significant hypotension and tachycardia, despite further aggressive resuscitation. Given the CT head findings and the FAST findings, the decision is made to take the patient emergently to the operating room (OR) for a right-sided craniotomy and subdural hematoma evacuation with consideration for leaving the bone flap out depending upon operative findings, and a simultaneous exploratory laparotomy. In order to provide appropriate access for the neurosurgery, trauma surgery, and anesthesia teams, a collaborative approach to patient positioning is required.

Positioning for Simultaneous Surgeries

As illustrated in the case presentation, the hypotensive polytrauma patient harboring multiple severe injuries requires evaluation by trauma surgery, neurosurgery, anesthesiology, and orthopaedic surgery. It is imperative that close and ongoing communication occurs between these surgical teams in order to facilitate prioritization

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of those injuries requiring immediate intervention, and ongoing decision-making and coordination of emergency operations, including timing, resuscitation needs, and positioning. A polytrauma patient may present with a traumatic brain injury (TBI) and intracranial surgical lesion and hypotension and/or hypoxia from extracranial injuries necessitating emergent thoracotomy, laparotomy, or pelvic fixation. They may also have other orthopaedic injuries (fractures of upper or lower extremity long bones or acetabulum) requiring surgical repair and, stable or unstable spine injuries [1].

Cervical spine instability can result from ligamentous injury and/or fractures; subluxation or malalignment can lead to permanent spinal cord injury (SCI) and a range of neurological deficits. Endotracheal intubation of the trauma patient should therefore be performed in a neutral position and hyperextension should be avoided during intubation. Log roll procedures should be used at all times during patient transfers, radiological testing, and operating room positioning, in case of thoracic or lumbar spinal column injuries.

Patients with traumatic brain injury who also have intrathoracic or intra abdominal injuries, long bone, acetabular or pelvic fractures, or SCI, may experience hypotension from blood loss or spinal shock. Preventing secondary brain injury by avoiding hypotension and hypoxia is paramount due to the dramatic impact these events have on outcomes after severe TBI (sTBI) [2]. Major extracranial injuries in patients with sTBI are common; incidence is reported in 20–41% of sTBI patients [1]. The need for the simultaneous surgical treatment of intracranial and extracranial injuries is relatively rare; however, the operating room logistics are complicated and time is of the essence in the setting of trauma, particularly with those *in extremis* [3]. Consideration of how to proceed should be given beforehand and all neurosurgeons and trauma surgeons should be prepared mentally before ever encountering the situation in reality.

The proper positioning of the trauma patient in the operating room requires that each team have appropriate access to the patient. A hypotensive trauma patient with a traumatic brain injury may require a thoracotomy, laparotomy, or pelvic fixation concurrent with a craniotomy [3], all of which can generally be done in the supine position on a standard operating room table [4]. The anesthesia team and machines may be placed to one side of the patient contralateral to the craniotomy side and excluded with sterile draping. This is the most expeditious manner in which to set up the room for simultaneous surgeries. Conversely, the patient may be turned 180° from anesthesia, but in this type of scenario, it can be difficult for them to perform all of the necessary procedures (often done under the drapes) and monitor all of the necessary parameters. See Fig. 17.1 for the recommended room setup for simultaneous trauma surgeries.

In cases requiring concurrent surgery, the anesthesiologist must sometimes secure and always maintain access to the airway. If possible, the endotracheal tube should be taped contralateral to the craniotomy side, and an ETT extender used so that the tubing can be directed away from the operative site and protected from pressure from instruments and the hands of the neurosurgeons as they work. Further, access is required to the neck, groin, and limbs for placement of and monitoring of intravascular venous lines that are necessary for ongoing resuscitation with fluid and blood products, and for obtaining serum samples for multiple laboratory studies that will be required throughout the case (e.g., electrolytes, glucose, blood count, coagulation studies). While preferentially lines will have been obtained in the resuscitation room, the rapidity with which patients are taken to the OR may result in suboptimal placement, dislodgement, occlusion, or other malfunction requiring intraoperative replacement. Access to the wrists and groins for arterial line placement and monitoring must also be maintained, as these are required for continuous blood pressure management and acquisition of arterial blood samples for arterial blood gas measurements. Finally, the Foley catheter and drainage system should be positioned between the legs, secured to the thigh, and hung on the anesthesia side (contralateral to the craniotomy) so that the anesthesia personnel can continuously

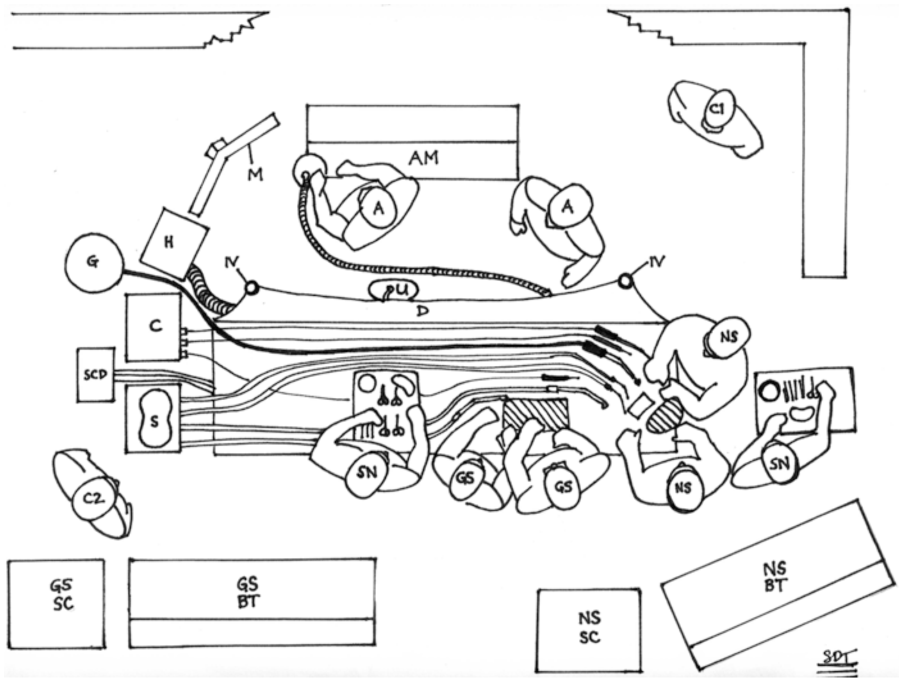

Fig. 17.1 Setup for simultaneous emergency trauma craniotomy and laparotomy. Key: *A* anesthesiologist, *AM* anesthesia machine and cart, *C* cautery unit, *C1* and *C2* circulator 1 and circulator 2, *D* drape, *G* gas cylinder, *GS* general surgeon, *GS BT* general surgery back table, *GS SC* general surgery supply cart, *H* heating blanket unit, *IV* IV pole, *M* monitors, *NS* neurosurgeon, *NS BT* neurosurgery back table, *NS SC* neurosurgery supply cart, *S* suction, *SCD* serial compression device unit, *SN* scrub nurse or technician, *U* urinary catheter collection receptacle

assess the urinary output. Should it drop precipitously, the catheter must be checked for kinking under the drapes, in order to ensure that obstruction is differentiated from hypoperfusion as the etiology of the oliguria. Output must be monitored when mannitol or other diuretics are given to aid with cerebral edema. Finally, the anesthesia team may also need to repeatedly check for blood loss from other injuries under the drapes especially scalp lacerations, facial injuries, compound fractures, and femur/acetabular fractures).

There needs to be ready access to the anesthesia machine and ventilator, as well as adequate space for at least two people to stand in the anesthesia area, due to multiple simultaneous ongoing needs for not only the above intensive monitoring, but also administration of fluids, blood products, and medications. There must be simultaneous ongoing monitoring of the patient's physiology with direct line-of-sight to all displays of vital signs, ventilator settings, respiratory pattern displays, and any implanted neuromonitoring devices such as intracranial pressure read-outs. Finally, the anesthesia team should be placed for ready verbal communication with the surgical teams, circulator, and telephone or voice communication device for rapid communication with the laboratory, the blood bank, and pharmacy. The display monitors should also be positioned so that the surgical teams can quickly, easily, and frequently look up to ascertain the vital signs without resorting to verbal communication, as this can be difficult with multiple ongoing teams talking simultaneously to assistants, technicians, and one another. Noise in the room should be kept to a minimum and conversation should be limited to only that which is essential to the care of the patient.

The neurosurgeon must have access to the head and maintain a sterile field given the high morbidity of intracranial infection. To approach the hemicranium, the patient may be positioned on a gel or foam doughnut headrest with a roll under the ipsilateral shoulder and the neck kept in neutral position with the collar kept in place. The Mayfield head-holder is not required for precision in such an operation and takes additional time that may prove detrimental. Furthermore, placing a patient in fixation pins while multiple teams are working to position, prep, and drape the patient placed the surgeon and assistants as well as the patient at risk for inadvertent lacerations and punctures. The patient should be placed with the vertex of the head slightly overhanging the top of the operating table (2–3 cm) from the very beginning in order to avoid further position changes. This aids in drainage of irrigation fluid downward into the craniotomy drape drainage bag. The contralateral upper extremity is extended on an arm board toward the anesthesia team, and the ipsilateral upper extremity is laid across the upper torso toward anesthesia (for wrist access), but cephalad enough to allow the abdomen to be prepped and accessed by the trauma team. (See "Complications" section below.)

The hair of the entire hemicranium should be quickly clipped to maximize visual inspection for traumatic contusions, hematomas, abrasions, and lacerations around which the incision may need to be planned. Towels are stapled to the cranium to outline a generous exposure to accommodate a large incision and craniotomy. (Alternatively, adhesive paper drapes may be used, but these often become dislodged in rapidly moving emergency cases.) The positioning of the head is done with the slight overhang so that the drainage bag on the adhesive craniotomy drape hangs straight down to properly collect the hemorrhage and irrigation that can be expected to occur in a "crash craniotomy" scenario. If the drainage bag is horizontal and not vertical as it is designed to be placed, spillage of irrigation, bone dust, and blood is difficult to keep clear of the operating field. As a result of fluid pooling, strike-through can occur, or drape separation from the weight of the material pooled on the drapes. Not only does this represent an infectious risk but floor spillage and overflow represents a significant slip risk to surgeons and operating room personnel, especially in a fast-moving crowded scene. Rapidly moving through such a case while maintaining meticulous attention to hemostasis is critical, due to the major blood loss the patient has already experienced and hemodynamic instability. The OR technician or nurse assigned to the neurosurgery team and the back table and Mayo stand for instruments should be positioned at the patient's ipsilateral shoulder.

The neck must be maintained in a neutral position and the collar left in place in the setting of a known or suspected cervical spine injury. This can be challenging in cranial operations involving significant soft tissue injury, especially lacerations and scalp avulsions, that may require non-standard incisions. Heavy scissors may be used to cut out a small portion of the collar to allow sufficient exposure for the inferior limbs of cranial incisions. (This is also an issue when surgery of the posterior fossa is needed, a fortunately unusual event in acute trauma, as this requires the prone position in Mayfield head-holder and fixation pins, and poses a higher risk to the spinal cord during the turning of the patient prone.) See below for further discussion of spinal column injury handling.

The thoracic or trauma surgeons must have access to the chest and abdomen to perform necessary life-saving procedures, including chest tube placement, thoracotomy, and laparotomy. Orthopaedics may also need to have access to the pelvis. All of this can be obtained from the same side as the craniotomy, with the OR technician or nurse and instrument table positioned at the patient's feet.

A thoracotomy may require the lateral position which is also acceptable for a simultaneous craniotomy. The patient should be positioned using standard lateral decubitus techniques, craniotomy side up. He or she may be flexed at the hips but special care to maintain the patient's spine in a neutral position is imperative, so inflatable "bean bag" or gel positioners (placed before the patient is put on the OR table), rolls and pillows, and tape and straps must be strategically placed to maintain neutral spinal alignment throughout the case. The upper arm may be placed on a padded Mayo stand or elevated arm board and will need to be cephalad enough to be

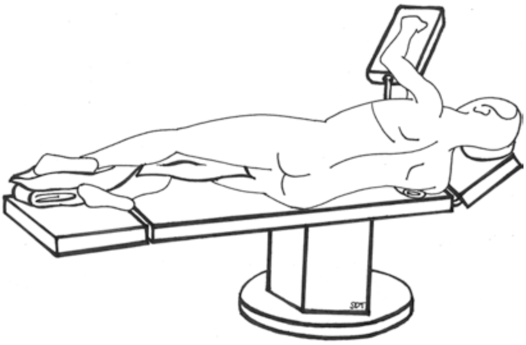

Fig. 17.2 Positioning for simultaneous emergency trauma craniotomy and thoracotomy

out of the way of the thoracic or trauma team, but not over the face and head, so as to allow access for the neurosurgical team (see Fig. 17.2). The anesthesia team may need to repeatedly check position to ensure alignment is maintained through the case, and of course padding needs to be employed as able to avoid pressure points, but this is of secondary consideration for such an extreme emergency and should not delay surgery. (If a thoracotomy is required contralateral to the craniotomy, the position may need to be performed supine, although this is challenging. In this case, the arm is usually elevated to allow improved access to the lateral thorax).

Repair of closed long bone fractures or spinal column fractures without neurological deficit should be delayed, ideally until the patient is hemodynamically stable, surgical intracranial mass lesions have been addressed, and intracranial pressure has been stable within the normal range (typically for at least 24 h). Conversely, pelvic fractures causing exsanguination may require intraoperative fixation with an external compression or pin-fixation device simultaneous to craniotomy to stave blood loss and reverse hypotension. Other exceptions include compound extremity fractures or majorly displaced femur or acetabular fractures. Compound fractures may result in exsanguination or ongoing blood loss (in addition to the infection risk) and can undergo irrigation and application of an external fixation device while other procedures are ongoing or immediately after their completion. They should never be left unattended and unobserved under a drape, but should be rapidly wrapped with sterile gauze and immobilized until such time as this can be performed, with the anesthesia team or other operating room personnel checking under the drapes frequently to assess for ongoing blood loss, about every 15 min until stable if all other events are under control.

Femur and acetabular fractures can also result in massive blood loss into the soft tissue of the thigh. Again, operating room personnel should check for thigh swelling under the drapes frequently. Immobilization of compound fractures and femur or acetabular fractures prevents ongoing tissue trauma and disruption of clotting, and therefore aids in hemostasis. Failure of the patient to respond to ongoing resuscitation efforts should prompt additional re-evaluation of injuries under sterile drapes to assess for ongoing blood loss, especially for those with coagulopathy.

As previously noted, spinal precautions should be maintained as much as possible throughout the initial life-saving emergency surgeries, until a more thorough evaluation of spinal column injury and instability and neurological status may be completed. Spinal cord injury with ongoing cord compression causing a deficit may need to be addressed soon after the initial surgery, but is not typically done in the same setting, unless cervical traction is required (made more difficult by surgical cranial defects). This could be performed under the same anesthetic after any necessary life-saving cranial, thoracic, abdominal, or pelvic surgeries have been completed. However, open surgeries for spinal decompression, stabilization, and fusion are typically done in a subsequent OR setting, and only after hemodynamic stability has been achieved and maintained for a significant length of time.

While modern CT alone is sufficient for experienced and trained interpreters to detect unstable cervical spine injuries in trauma patients, there is frequently no time to adequately review the study prior to emergency craniotomy, beyond a cursory look for major abnormalities (fractures and malalignments). However, should time allow, a thorough review of the CT may allow for removal of the cervical collar and more freedom with operative positioning [5].

Complications

Hernandez et al. [4] found the position described above to be acceptable by 24 of 29 general surgeons (82.76%) and 12 of 12 neurosurgeons (100%). However, the most notable concern, after appropriate access to the patient for all surgical teams and the anesthesia team, is brachial plexus stretch injury due to extension of the ipsilateral arm. While nerve stretch injuries in general occur in less than 1% of surgeries, they may be observed in every body position and may occur as early as 15 min post-positioning [6]. The brachial plexus can be injured by ischemia, compression, or stretch. These lesions are usually not permanent; however, recovery can take up to 18 months or more (leading to muscle atrophy and contracture, sensory loss and skin injury, or atrophic skin changes) so minimizing their occurrence is important. There are several ways to help minimize the chance of brachial plexus injury in the polytrauma hybrid position. First, there must be adequate elevation of the ipsilateral extremity in order to prevent hyperextension and traction on the brachial plexus from the weight of the extremity or arm straps/tape. Additionally, in supine or prone positions, the arm should generally not be abducted at the shoulder above 90° in order to avoid stretch injury (This would be improbable in the supine position for a craniotomy, as higher abduction would impair exposure.). Finally, careful placement of a vacuum “bean bag,” gel positioner, and/or tape and safety belts to secure the patient’s position and ensure that it does not change from sliding on the operating table if the table is rotated can also help avoid brachial plexus stretch injury [7].

The second concern with this hybrid positioning is that the elevation of the ipsilateral side by the shoulder roll makes the contralateral shoulder and flank dependent, causing potential for extra pressure. As long as the patient is secured to the table appropriately, the operating table can be rotated to bring the contralateral flank, abdomen, and shoulder into better position [4]. However, this may impair cranial access.

In summary, positioning of the polytrauma patient requires cooperation between the anesthesia team, all involved surgical teams, and all OR personnel. Protection of the spine during intubation and positioning as well as avoidance of hypotension and hypoxia in order to prevent secondary brain injury is critical. All teams must carefully and rapidly consider the ramifications to the other teams of positioning required for their operation. Verbal communication amongst all involved should be succinct, clear, and efficient.

The Morbidly Obese Patient

Case 2 Presentation

A 52-year-old female is seen in neurosurgical consultation due to severe back pain radiating into the right leg that started with a “pop” in her back that occurred when she bent over to pick up an object. On physical examination, she has a positive Lasegue’s sign (straight leg raise test), and dorsiflexion on the right is weak at 4−/5. An MRI obtained on a special unit shows an L4–5 disc herniation with significant compression of the traversing right L5 nerve root. The patient has tried a Medrol dose pack and rest with no improvement in her symptoms. Her weight is 190 kg, her height is 5 ft. 5 in., and her BMI is 69. Her past medical history includes hypertension, hypercholesterolemia, and poorly controlled diabetes mellitus. Given the failure of medical management, the MRI findings, and the motor weakness on physical examination, surgical intervention is recommended. The patient is referred to the anesthesia clinic for preoperative evaluation. An electrocardiogram, chest X-ray, and laboratory workup are obtained, with no significant abnormalities except hyperglycemia, and a microscopic lumbar discectomy is scheduled.

Positioning of the Morbidly Obese Patient

Morbid obesity is a significant health problem with increasing incidence. A Body Mass Index (BMI) of 25 kg/m^2 and below is considered to be normal, a BMI of 25–30 kg/m^2 is low risk, 30–35 kg/m^2 leads to moderate risk from complications of obesity and a moderate anesthesia risk, 35–40 kg/m^2 is considered high risk, and above 40 kg/m^2 is considered "serious morbid obesity" with very high risk [8]. The patient in the case presentation has a BMI of 69 placing her in the "very high risk" category.

Obese patients have decreased chest wall compliance and inefficient respiratory musculature. With increasing obesity, the work of breathing is increased and with increasing weight, the intra-abdominal pressure is increased, while the total lung capacity and functional residual capacity are decreased [9]. Prone positioning is associated with predictable changes in physiology and also with a number of complications, all of which become more pronounced in the setting of morbid obesity. Thus, preoperative optimization, careful placement into the prone position (or consideration of alternatives), and effective communication between the neurosurgical and OR teams becomes even more crucial [7].

As well as the standard preoperative evaluation, one should consider obtaining an electrocardiogram, and even an echocardiogram as well as a lower extremity duplex to rule out deep vein thrombosis before prone positioning in the morbidly obese patient. Invasive arterial monitoring should be used if cardiopulmonary disease is present, and for those with the inability to gain an accurate cuff pressure due to size discrepancy/poor fit. Central venous catheterization should be considered in those with obesity, cardiopulmonary disease, and poor peripheral venous access [10].

Appropriate selection of operating room equipment must also be considered. Many operating room tables can support patient who weigh up to the 350–500 pound range, and special tables have been designed to support patient who weigh more. However, it must be noted that some OR tables, once articulations in the table begin to be mobilized, may not hold the same amount of weight in certain configurations. Morbidly obese patients have an increased risk of falling off of the operating room table due to weight load shifts and instability. Providing extra support and carefully securing the patient are thus paramount. Adequate padding also becomes more important because the extra weight leads to additional pressure on any areas that come into contact with the operating room table or equipment [11], with the attendant risk of decubitus ulcer formation and nerve compression syndromes, even with relatively short cases. As obese patients are often diabetic, their risk of positioning peripheral neuropathies is cumulatively affected.

Positioning an obese patient in any position, supine, lateral decubitus, "park bench," prone, sitting, or otherwise is challenging and fraught with risk. There is a risk of the patient falling due to personnel being unable to maintain the patient's position while securing him or her, inappropriately sized operating tables and equipment, or partial emergence from anesthesia due to increased drug requirements resulting in patient movement during surgery. Injury to the skin can occur simply from the pressure of straps required to secure patients in place, as they must often be placed under higher tension in the obese patient to be effective. Pooling of prep solutions in the dependent intertriginous areas may result in maceration of tissue, so care must be taken during sterile prep to avoid this. Risk of radiation injury due to increased fluoroscopic requirements for adequate visualization is also higher in obese patients, providing additional challenges to long-term skin integrity. Adjunctive circumferential imaging devices sometimes cannot be used, as they will not fit around the patient, even on a Jackson table. The placement of adjunctive lines, such as IVs, arterial lines, central venous catheters, and urinary catheters may be more difficult. Increased infection risk from diabetes or inability to keep surgical sites adequately cleansed postoperatively are also factors.

The prone position itself has adverse effects on epidural venous pressure and airway pressure in all patients, and these effects are more pronounced in the obese patient [12]. Pressure on the abdominal wall may further accentuate the restrictive nature of the pulmonary disease common in this patient population. The high airway pressures required to ventilate these patients may lead to barotrauma or difficulty with ventilation and cardiopulmonary function. Furthermore, the attendant impaired venous return and cardiac output can lead to decreased spinal cord perfusion and excess surgical blood loss for the neurosurgeon [13, 16].

Palmon et al. compared peak airway pressure, pleural pressure, and mean arterial pressure in patients undergoing posterior spinal surgery in the prone position with a "normal" BMI, a "heavy" BMI, and an "obese" BMI [13]. Obese patients positioned prone on a Wilson frame had an increase in mean arterial pressure and peak airway pressure and a decrease in pulmonary compliance. All patients positioned on chest rolls had an increase in peak airway pressure and a decrease in pulmonary compliance. On the other hand, when using the open Jackson table, there was no change in peak airway pressure or compliance when moving from the supine to the prone position.

All three of these surgical positioners are designed to allow the abdomen to be suspended during prone surgery; however, in the obese patient, the abdominal girth does not allow for its suspension with chest rolls, and even with the Wilson frame in the larger patients. Furthermore, the Wilson frame may tip when expanded high enough to accommodate larger patients and their size and weight may exacerbate this phenomenon. Especially with the Wilson frame, the surgeon and assistant must often be required to stand on step stools to operate at the appropriate height, which can make simultaneous utilization of the microscope, drill, and bipolar cautery more difficult. Reduction of abdominal and thoracic pressures and optimization of respiratory mechanics and venous return thereby improving ventilation, spinal cord perfusion, and surgical blood loss can be achieved by using the Jackson table for obese patients (see Fig. 17.3). In all cases, the table should be placed at the lowest height and even with the bed prior to rolling the patient over to the table into the prone position.

Another option is to adjust the patients positioning based upon obesity status; for example, using the lateral or sitting positions to approach the posterior fossa or the spine instead of the prone position. This is not just an issue related to patient physiology. Depending upon the stature of the surgeon, certain positions may not allow

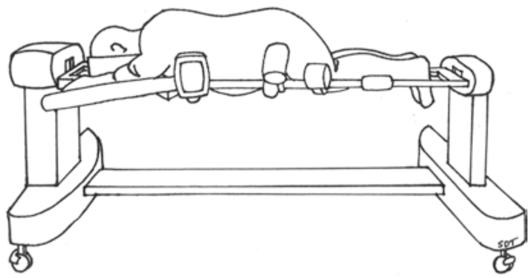

Fig. 17.3 Positioning for the morbidly obese patient

the surgeon to reach the exposed area to operate. It can be especially difficult, even with standing step stools, for surgeons to adequately visualize the depths of exposure of a midline spinal incision in a morbidly obese patient, let along perform the surgical manipulations necessary to carry out the operation safely, effectively making it impossible to position the patient prone.

Several studies [14, 15] discuss the use of awake intubation and prone self-positioning as a method for decreasing anesthetic complications and minimizing pressure points during positioning of a morbidly obese patient. In this model, a topical anesthetic and IV sedation are used for awake fiberoptic intubation. The patient is then disconnected from the circuit and allowed to position themselves which minimizes pressure points, skin integrity compromise, and nerve injury. Additionally, spontaneous and adequate oxygenation and ventilation in the prone position can be confirmed before induction of general anesthesia. Patient cooperation and the ability to communicate non-verbally with the operating room team are key for awake intubation and prone self-positioning in the morbidly obese spine patient making patient selection key.

Complications

Morbid obesity is also a risk factor for the development of ischemic optic neuropathy (ION) and subsequent partial or total blindness. While ION may occur in any patient who has been placed prone for surgery, Lee et al. demonstrated in a large multi-institutional study that the odds ratio for ION in the setting of obesity was 2.83 with a confidence interval of 1.52–5.39 [17]. There is no effective treatment for ION so extra vigilance with protective strategies is required.

Positioning should include careful facial padding and support, and visual conformation that the globes are free from pressure. A square foam pad with cut-outs for the face and endotracheal tube is a popular and safe option for use with regular or Jackson flat-top tables. Alternatively, a horseshoe headrest may be used, but these, even when padded, may not appropriately fit the patient's head and face, and therefore risk pressure to the globes. A Mayfield pin-fixation headholder device may also be used, but with very large individuals, the soft tissue may be sufficiently thick that the pins cannot gain adequate penetration of the skull for secure fixation. Furthermore, the face, chin, and neck may be in contact with the metal frame of the Mayfield, rendering it ineffective at avoiding pressure. Finally, cervical fat pads may make it impossible to flex the neck adequately to access the posterior fossa and cervicomedullary junction.

To help avoid ION, the head should be maintained at or above the heart to reduce venous congestion. Minimizing duration in the prone position, maximizing hemostasis, and the use of colloid (and blood products if necessary) to minimize crystalloid administration decrease the risk of ION. However, ION may occur even when all proper precautions are taken and no untoward intraoperative events occur.

In conclusion, positioning for surgery in the morbidly obese patient has a unique set of challenges and pitfalls. Sufficient preoperative workup of cardiac and pulmonary function and glycemic control are important preventive measures to inform the surgeon of the patient's suitability for general anesthesia and surgery in general, and may guide positioning decisions. Placement of arterial lines and central venous catheters should be considered, and the option of awake intubation and self-positioning may be discussed with the patient. Intra-abdominal pressure in the prone position can be minimized by using a Jackson table to improve ventilation, decrease peak airway pressure, improve venous return, and maximize cardiac output. Extra care must be taken when positioning to avoid peripheral nerve injury, decubitus ulcers, and ischemic optic neuropathy.

Conflict of Interest The authors declare no conflict of interest.

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