A Review Paper

Challenges of Spine Surgery in Obese Patients

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Abstract

Obesity, one of the most common health problems in the United States, is becoming more prevalent. At the same time, because of technological advances, the rate of spine surgeries is on the rise. Given these trends in obesity and spine surgeries, it can be inferred that the number of obese patients who undergo spine surgeries will increase as well.

When spine surgeries are planned for obese patients, several factors must be considered. Obesity is closely correlated with additional medical comorbidities including hypertension, coronary artery disease, and diabetes mellitus. Preoperative evaluation may be more difficult, as more extensive medical testing may be needed. Adequate radiographic images can be difficult to obtain because of patient size and equipment limitations. Administering anesthesia becomes more difficult, as does proper patient positioning. After surgery, obese patients are at higher risk for wound infection and deep vein thrombosis.

Nevertheless, appropriate clinical outcomes can be achieved in obese patients who undergo spine surgery. Obesity is not a contraindication for spine surgery. Patient selection is key in achieving favorable clinical outcomes.

Obesity is one of the most prevalent health problems in the United States. Recent studies have found that 32.2% of men and 35.5% of women in the United States are obese.[1] In addition, prevalence has increased, notably among adolescents and men.[2] At the same time, because of technological advances, the rate of spine surgeries is on the rise—particularly spinal fusion procedures, which tripled between 1990 and 2000.[3] In 2003, spinal fusion was the 19th most common inpatient procedure, up from 41st in 1997.[4]

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In this article, we review the effects of obesity on spine surgery patients and highlight the factors that must be considered when planning spine surgeries in obese patients.

Definition of Obesity and Associated Comorbidities

Most clinicians use a standardized formula, the body mass index (BMI), to define obesity. This formula was created by Belgian statistician Adolphe Quetelet in 1832 and then was mostly abandoned.[5] In 1972, it was thrust to the front of obesity research by Keys and colleagues,[6] who evaluated the then available methods for describing the relative weight of patients or populations. They chose the easiest and most reproducible method, which they renamed BMI. This simple formula requires no special tools or data, as it is simply the patient's weight (kg) divided by the square of the patient's height (m^2). Based on this information, guidelines have been set for classifying patients as underweight, normal weight, overweight, obese, or morbidly obese (Table).[7]

Obesity is closely correlated with higher rates of multiple medical comorbidities, including diabetes mellitus, hypertension, coronary artery disease, obstructive sleep apnea, and overall mortality.[2,8-10] This correlation has specifically been found in spine surgery. Vaidya and colleagues[11] reported means of 5.1 comorbidities for obese patients and 8.1 comorbidities for morbidly obese patients who underwent posterior decompression and fusion with instrumentation. Thus, not only does presence of obesity affect the incidence of medical comorbidities, but the degree of obesity is also important. The higher rates of diabetes in these populations must also be carefully considered, as patients with diabetes have more wound complications.[12,13]

Obesity as a Causative Factor in Spinal Pathology

Although many obese patients develop spinal disorders, it is controversial whether obesity is truly a causative factor in the development of spinal pathology. Some studies have shown that obesity is an independent risk factor in development of low back pain.[14] In a review, Mirtz and Greene[15] concluded that a BMI of 30 to 40 carries a moderate risk for low back pain, and a BMI above 40 confers a moderate to high risk. Garzillo and Garzillo[16]

Table. Patient Weight Classification According to BMI

BMI	Degree of Obesity
<18.5	Underweight
18.5-24.9	Normal
25.0-29.9	Overweight
30.0-39.9	Obese
≥40.0	Morbidly obese

Abbreviation: BMI, body mass index.

noted a possible correlation between severe obesity and low back pain, whereas Leboeuf-Yde and colleagues[17] found only a modest association. Liuke and colleagues[18] evaluated the incidence of degenerative disk disease in the lumbar spine in overweight (BMI >25) patients at baseline and 4-year follow-up and concluded that being persistently overweight increased the risk for disk degeneration, and being overweight at a younger age increased the risk for degenerative progression to multiple levels. However, other investigators have found no direct correlation between obesity and radiographic disk degeneration or low back pain.[19] Furthermore, Patel and colleagues[20] noted that the incidence of obese patients undergoing elective thoracic and lumbar fusions was consistent with the distribution in the overall population.

Obesity and Preoperative Evaluation

Obesity can also affect diagnostic assessment for spine surgery. Patients who undergo spine surgery typically obtain multiple preoperative imaging studies. These usually include plain radiographs and computed tomography (CT) and magnetic resonance imaging (MRI) scans. Use of these studies contributes to accurate diagnosis and appropriate preoperative planning, but obtaining proper images in obese patients can be difficult. With plain radiographs, for example, decreased tissue penetration may require higher radiation doses and result in poorer image quality. Use of digital imaging and effective techniques can help minimize these issues.

With cross-sectional imaging modalities, there are special concerns regarding patient size and weight. Larger patients may "tweak" the tables used in these finely calibrated machines and, thereby, reduce image quality. In addition, some obese patients may not be able to fit inside the tubes used in this equipment—conventional aperture diameters are approximately 70 cm for CT and 60 cm for MRI—and others may become claustrophobic in such confined spaces. "Standing" or "open" MRI systems were developed to address such issues. These systems have larger apertures, averaging 70 cm, but the trade-off is use of smaller magnets, which may limit image quality. Some newer, traditional-style MRI systems have table limits of approximately 250 kg or more, and aperture diameters of 70 cm. Unfortunately, the availability of these machines may be limited.[21]

Obesity and its commonly associated comorbidities alter the preoperative medical evaluation for surgical clearance. For instance, the common comorbidity of hypertension may contribute to the development of ischemic cardiomyopathy and subsequent ventricular dysfunction. In addition, obesity increases the risk for arrhythmias, likely through fatty and ischemic changes in the myocardium. Respiratory function may be altered, as obese patients exhibit decreased chest wall compliance secondary to adiposity of the chest wall and abdomen—leading to a higher workload of breathing and a decreased functional residual capacity. Obese patients also have a high rate of obstructive sleep apnea. Other considerations include an increase in gastroesophageal reflux disease, fatty changes in the liver, endocrine and metabolic disturbances, including hypercholesterolemia and diabetes, and potential coagulopathies.

In the preoperative evaluation of obese patients, such factors necessitate blood tests for hemoglobin, electrolyte, blood glucose levels, liver function, and clotting profile. Chest radiograph, pulmonary function tests, and electrocardiogram (ECG) are also recommended. When ECG abnormalities are noted, further evaluation is likely needed, including echocardiogram, cardiac stress test, and cardiology consultation.[22,23]

Effects of Obesity in the Operating Room

Establishing intravenous access may be more difficult in obese patients. Problems may begin with administration of anesthesia. Obese patients have lower functional residual capacity, and patients with severely reduced functional residual capacity can experience premature airway closure and ventilation–perfusion mismatches leading to hypoxemia. The result during induction of anesthesia is a shorter period of nonhypoxic apnea—the period between paralysis and intubation, before hypoxia occurs. Furthermore, large tongues and narrow airways, common in patients with obstructive sleep apnea, may make securing an airway more difficult, and fiberoptic intubation techniques may be necessary. Rapid induction of anesthesia is imperative in obese patients given their high risk for aspiration. Esophageal reflux is common and 75% of obese patients have a high-volume, low-pH gastric residue that places them at risk for pneumonia. In severely obese patients, use of positive airway pressure during preoxygenation and induction may minimize hypoxia associated with the apneic phase of standard intubation. The increased adiposity provides a larger distribution area for certain anesthetic agents, which may make appropriate dosing more difficult.[24]

As obese patients have higher rates of wound sepsis, preoperative use of antibiotics is strongly recommended. The recommended prophylactic antibiotic for spine surgery is cephalosporin (cefazolin 1-2 g; 2 g for patient weighing >86 kg) or, in case of β-lactam allergy, clindamycin or vancomycin (dosing based on patient weight). The recommended procedure is to start the

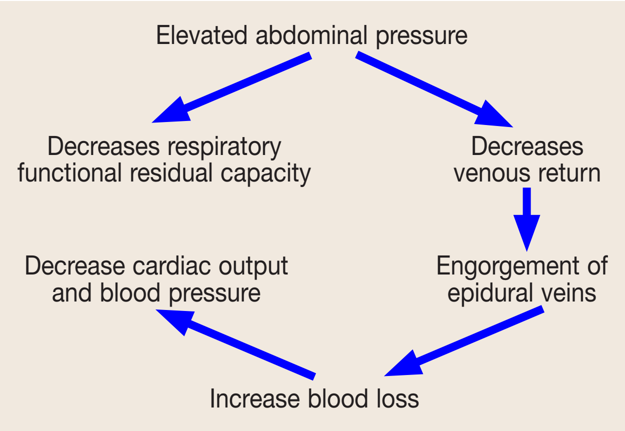

Figure. Effect of elevated abdominal pressure on cardiovascular and respiratory systems.

antibiotic up to 60 minutes before incision, stop it at time of incision, and redose antimicrobial every 4 hours during a prolonged procedure or in the event of significant blood loss. If a postoperative antibiotic is used, its doses should be discontinued within 24 hours after wound closure, as longer use after wound closure has not proved to be beneficial and, indeed, may contribute to the development of antimicrobial resistance.[25,26]

Positioning is more difficult, as many spine surgeries are performed with the patient prone. Degree of obesity plays a role. One study showed that morbidly obese patients have longer surgical setups.[11] Placement on an appropriate operative table is also crucial. Use of a closed-frame table, such as a Wilson frame, may contribute to an increase in intra-abdominal pressures, which may cause the diaphragm to become elevated and intrathoracic pressure to increase, leading to a decrease in venous return.[27] Decreased venous return can cause venous congestion, particularly along the epidural veins, and result in increased blood loss (Figure). Given these concerns, a common recommendation is to use an open-frame table, which allows the abdomen to hang free. The Jackson spinal table (Mizuho OSI, Union City, California), commonly used in spine surgery, has a patient weight capacity of 227 kg. A large abdominal pannus requires further modifications to allow for free passage of intraoperative fluoroscopy machines. Bariatric security straps provide a comfortable hold of the pannus and accommodate up to 454 kg.[28,29]

In this population, peripheral nerve palsies have been noted, most likely secondary to increased pressure on contact points and difficulty in positioning.[20] Brachial plexus stretch injuries may occur with shoulder abduction of more than 90°. Arm boards should be positioned to keep shoulder abduction under 90° and should be checked frequently by the anesthesia team during the surgical procedure. All bony prominences should be carefully padded to prevent pressure points from developing.

As higher radiation doses are needed for adequate tissue penetration in obese patients, these patients and the operative personnel are exposed to higher levels of radiation.[30] Larger patients require longer incisions and more extensive soft-tissue dissection, and there may be certain technical difficulties, such as obtaining the appropriate angles for pedicle screw placement.[31] Anterior lumbar spine surgery is quite challenging in obese patients and perhaps is avoided in some cases. Special deep retractors or extralong instruments should be available. Peng and colleagues[32] evaluated different factors in obese and nonobese patients undergoing anterior lumbar surgery and concluded that both exposure time and total surgical time are longer in obese patients. Obese patients also had longer incisions and increased skin-to-fascia and fascia-to-spine depths. Estimated blood loss, however, was not significantly different. Rosen and colleagues[33] noted no difference in operative outcomes between obese and nonobese patients who underwent minimally invasive surgery for lumbar fusion, perhaps because the tubular retraction system used in these procedures allows skin incisions of similar sizes in all patients. Reducing operative time in spine surgery is important, as longer times are associated with increased risk for infection, and for blindness in prone patients—this complication has been found in lengthy surgeries.[34,35]

Obesity, Postoperative Complications, and Hospital Course

The postoperative effects of obesity have remained controversial. Studies in general surgery patients indicated an increase in wound infections with open procedures, but no other differences.[36] Obese cardiac surgery patients had higher rates of superficial sternal and leg infections and atrial dysrhythmias, but not overall mortality.[37] Total hip and knee arthroplasty patients showed no difference in complications and postoperative course.[38]

Postoperative development of deep venous thrombosis is of particular concern in this population. Both obesity and recent surgery are independent risk factors for deep venous thrombosis.[39,40] Postoperative spine patients require special consideration, as chemical prophylaxis in the acute postoperative period carries an increased risk for epidural hematoma and subsequent neurologic compression and deficits.[41] Thus, mechanical prophylaxis (eg, compression stockings, sequential compression devices) is of utmost importance. It should be started during surgery and continued throughout the postoperative hospital course. Proper fitting of devices may be difficult with an obese body habitus. Early ambulation is also important. Patients should begin to walk no later than postoperative day 1.

The most common complication in obese spine patients is wound infection.[42-44] Patel and colleagues[20] found a correlation between higher BMI and higher risk for major complications after elective thoracic and lumbar fusion procedures. Patients with a BMI of 25 had a complication rate of 14%, those with a BMI of 30 had a 20% rate, and those with a BMI of 40 had a 36% rate. In thoracic and lumbar fusion patients, Shamji and colleagues[31] noted an increased transfusion requirement and a higher likelihood of discharge to an assisted-living facility, but no differences in length of stay, infection rates, or overall mortality. Other investigators have noted no difference in complication rates between obese and nonobese spine patients.[45-47]

Obesity has been reported to account for increased airway compromise after anterior cervical spine surgery.[23] The reported incidence of reintubation after anterior cervical spine surgery ranges from 1.7% to 2.8%.[23] The recommended method for avoiding this complication is to ensure adequate hemostasis before wound closure. Suction drains should be used after surgery and patients should be closely monitored during the early postoperative period. They should be kept intubated for 24 to 48 hours after prolonged or difficult surgery. Airway patency should be confirmed by deflating the cuff before extubation. Diuresis, elevation of the head of the bed, and use of inhaled or intravenous steroid medications may also help reduce postoperative airway edema. Patients with life-threatening airway compromise and apparent swelling at the incision site (caused by postoperative hematoma formation) are candidates for urgent wound incision and drainage at the bedside or in the operating room.

Obesity Effects on Clinical Outcomes

Another concern is whether obese patients will have satisfactory clinical outcomes. According to Djurasovic and colleagues,[44] who examined the clinical outcomes of lumbar fusion in obese and nonobese patients, the groups' improvements were similar, as shown by their results on the Short Form 36 questionnaire, the Oswestry Disability Index (ODI), and back-and-leg-pain numerical rating scales. Revision rates were similar as well (revisions were performed to address adjacent segment disease). Similar clinical improvements for obese and nonobese patients have also been noted in minimally invasive surgery lumbar fusions and open lumbar decompressive procedures.[33] Evaluating obese and nonobese patients who underwent a variety of lumbar surgeries, Andreshak and colleagues[45] found no differences in hospital stays or clinical outcomes and concluded that proper patient selection is key in achieving successful surgical outcomes. Singh and colleagues[48] reported significant improvements in back pain, as measured with the ODI and a visual analog scale, after less invasive posterior lumbar interbody fusion in obese patients. Of these patients, 67% returned to normal preoperative employment within 12 months.

Conclusion

Obesity is not a contraindication for spine surgery, but surgeons must remain aware of special considerations and must take precautions before, during, and after surgery. The potential for longer operations, difficulties in anesthesia and operative positioning, increased blood loss, and more wound complications must be kept in mind. With proper patient selection and appropriate management of comorbidities, spine surgery can have satisfactory clinical outcomes for obese patients. Therefore, although the effects of obesity must be considered, obesity should not preclude surgical intervention.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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