Obesity, Orthopaedics, and Outcomes

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Abstract

Obesity, one of the most common health conditions, affects an ever-increasing percentage of orthopaedic patients. Obesity is also associated with other medical conditions, including diabetes, cardiovascular disease, pulmonary disease, metabolic syndrome, and obstructive sleep apnea. These comorbidities require specific preoperative and postoperative measures to improve outcomes in this patient population. Patients who are obese are at risk for increased perioperative complications; however, orthopaedic procedures may still offer notable pain relief and improved quality of life.

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Obesity is an increasingly prevalent health issue affecting individual patient care and the healthcare system. The extensive comorbidities associated with obesity affect nearly every organ system; the higher the body mass index (BMI), the greater the likelihood of more comorbidities. Obesity is linked to diabetes, cardiovascular disease, pulmonary disease, peripheral vascular disease, obstructive sleep apnea, liver disease, pancreatitis, certain malignancies, and even psychiatric disorders.[1] How obesity affects orthopaedic conditions and their treatment is less well publicized; guidelines to treat overweight and obese orthopaedic patients have not been established.

Diagnosing Obesity

Obesity is defined as increased body weight caused by excessive fat in an amount sufficient to cause increased health risks and reduced longevity. BMI is the most widely used measurement of obesity (Table 1). Waist circumference (ie, abdominal adiposity) has been suggested to be a more reliable predictor than BMI of health risks in overweight persons, including children and adolescents, and waist-to-height ratio (ie, waist size divided by height) may be a more effective screening tool for identifying cardiometabolic risk than BMI measurement or waist circumference. Measurement of body composition (ie, percentage of body fat) has been recommended for determining a safe weight in athletes because their increased muscle mass may skew BMI measurements. More sophisticated measurements of weight, such as bioelectrical impedance analysis, dual-energy x-ray absorptiometry, air-displacement plethysmography, and CT, are used primarily in research settings and generally are not available in most primary care settings.

Medical Comorbidities

Diabetes Mellitus

The importance of tight glucose control has been stressed in recent years. In 2010, the American Diabetes Association added the measurement of hemoglobin A_{1c} (HbA_{1c}) as a diagnostic tool for screening and diagnosis of diabetes, with HbA_{1c} levels >6.5% considered a diagnostic criterion for diabetes. The HbA_{1c} test reflects the average glucose level in the blood over the previous 2

Table 1

Diagnosis of Obesity

World Health Organization	
Normal	BMI 19.5 – 24.9
Overweight	BMI 25.0 – 29.9
Obesity	BMI ≥30
Generally Accepted Definitions	
Morbid obesity	BMI ≥40
Super obese	BMI ≥50
Classification of Obesity	
Class I	BMI 30.0 – 34.9
Class II	BMI 35.0 – 39.9
Class III	BMI ≥40

BMI = body mass index

to 3 months and is an indicator of the effectiveness of glucose control. Diabetic control is especially important because of the correlation between an increased risk of postoperative infection and glycemic control.[2] In a study of 790 trauma patients by Berrington de Gonzalez et al,[2] two or more blood glucose levels ≥200 mg/dL was an independent risk factor for 30-day surgical-site infection, even in patients without a history of diabetes. Ideally, HbA_{1c} levels should be stabilized at <7% before surgery; this level is associated with decreased infectious complications.

Cardiovascular and Pulmonary Disease

Cardiovascular and pulmonary disease should be considered in preoperative preparation. Medical optimization can notably reduce the frequency of postoperative complications. Hypertension is an independent risk factor for postoperative myocardial infarction after total joint arthroplasty, and the use of beta blockers for 7 days decreases the risk of cardiac ischemic events and in-hospital deaths.[3] The American College of Cardiology and the American Heart Association recommend administration of beta blockers well before the procedure, with dose titration based on blood pressure assessments and heart rate fluctuations.[4] Although the benefit of using a perioperative beta blockade is questionable, especially in patients with a low-to-moderate risk of cardiac events, it should be considered for use in obese patients who are at high risk for cardiac events.

Metabolic Syndrome

Metabolic syndrome refers to a combination of medical disorders that increase the risk of developing cardiovascular disease and diabetes. The distinguishing characteristics include insulin resistance, abdominal obesity, hypertension, and atherogenic dyslipidemia (ie, increased blood concentrations of low-density lipoprotein particles, decreased high-density lipoprotein particles, increased triglycerides). Insulin resistance represents the core of the pathophysiology of the disease, and an overabundance of circulating fatty acids is a major contributor to the development of insulin resistance. This situation initiates a cascade of events in every major organ system and results in a chronic prothrombotic and proinflammatory state.

Studies have examined the influence of metabolic syndrome on noncardiac surgical outcomes. A retrospective study of the American College of Surgeons National Surgical Quality Improvement database identified 20,845 patients with modified metabolic syndrome (mMetS) (ie, obesity, hypertension, diabetes) who were undergoing noncardiac surgery. The study revealed that mMetS increased a patient's risk for 30-day mortality, cardiac adverse events, pulmonary complications, acute kidney injury,

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stroke and coma, wound complications, and postoperative sepsis. Additionally, postoperative outcomes worsened with increasing levels of obesity in patients with mMetS.[5] Metabolic syndrome is also an independent risk factor for increased length of hospital stay, nonroutine disposition, increased cost, and the development of major complications for lumbar spinal fusion and hip and knee arthroplasty.[6]

Obstructive Sleep Apnea

Obstructive sleep apnea is a frequent comorbidity in obese patients and may be a factor in postoperative complications, including in-hospital mortality, pulmonary embolism, and wound hematomas or seromas. A simple, self-administered test, known as the STOP BANG test (Figure 1), can help identify patients at risk and predict the need for use of supplemental oxygen or a continuous positive airway pressure machine after surgery.

Figure 1

STOP

S (snore)	Have you been told that you snore?	Yes/No
T (tired)	Are you often tired during the day?	Yes/No
O (obstruction)	Do you know if you stop breathing or has anyone witnessed you stop breathing while you are asleep?	Yes/No
P (pressure)	Do you have high blood pressure or on medication to control high blood pressure?	Yes/No

BANG

B (BMI)	Is your body mass index more than 28?	Yes/No
A (age)	Are you 50 years old or older?	Yes/No
N (neck)	Are you a male with a neck circumference greater than 17 inches, or a female with a neck circumference greater than 16 inches?	Yes/No
G (gender)	Are you a male?	Yes/No

The more questions you answer YES on the BANG portion, the greater your risk of moderate to severe obstructive sleep apnea.

Stop Bang Sleep Test Questionnaire (Courtesy of Frances Chung, MBBS FRCPC, Toronto, ON, Canada.)

Obesity and Osteoarthritis

Osteoarthritis (OA) is frequently associated with obesity. Compared with patients who have a normal BMI, the need for a total knee arthroplasty (TKA) is estimated to be 8.5 times higher in patients with a BMI >30, 18.7 times higher in patients with a BMI >35, and 32.7 times higher in patients with a BMI >40.[7] Studies also confirm a statistically significant link between obesity and incidence of OA.[7] Theories proposed to explain the role of obesity in the development of OA include increased biomechanical loading on joints, replacement of lean muscle mass with high-fat mass, chronic low-grade systemic inflammation, and metabolic syndrome.

Obesity and Injury

Persons who are obese are predisposed to certain patterns of musculoskeletal injuries. In a cross-sectional study of 42,304 adults, Finkelstein et al[8] found that, compared with persons of normal weight, the odds of sustaining a musculoskeletal injury were 15% higher for persons with a BMI of 25 to 30 and 48% higher for persons with a BMI ≥40. In persons who are obese, low-velocity knee dislocations are more common and often accompanied by associated popliteal artery injury that requires repair. Ankle fractures are more frequent and more severe in obese persons than in persons who are of normal weight.

Obesity also notably affects the pediatric population. In a study of 356 pediatric trauma patients by Backstrom et al,[9] obese patients sustained more pelvic fractures, bilateral tibial fractures, and femoral fractures that required surgical treatment than did patients of normal weight. A cross-sectional study involving 913,178 patients aged 2 to 19 years found that overweight and obese children had statistically significant greater odds of lower extremity injuries and pain than did children of normal weight.[10] Children with a BMI in the 85th percentile for age are more likely to have persistent symptoms 6 months after sustaining an acute ankle sprain than do children of normal weight.[11] Both slipped capital femoral epiphysis and Blount disease occur more frequently in obese children.

Obesity is associated with a variety of musculoskeletal pain syndromes. Obesity is a strong independent risk factor for pain, nearly doubling the risk of chronic pain in the elderly,[12] affecting pain in soft-tissue structures such as tendons and fascia,[13] and exacerbating the symptoms of conditions such as fibromyalgia.[14] Back and lower extremity pain, especially of the knee and foot, is more common in obese children. In a population-based study involving 3,376 adolescents, obese adolescents were more likely to report musculoskeletal pain, including chronic regional pain, than were their normal-weight peers.[15]

Perioperative Considerations for Obese Patients

Preoperative Considerations

A surgical plan that considers all the special needs of a morbidly obese patient is critical and begins with the preoperative evaluation, including testing of electrolyte and glucose levels and a complete blood cell count. An electrocardiogram is recommended for all obese patients, followed by an echocardiogram if there are any signs of congestive heart failure. Renal function should be measured (ie, serum creatinine, proteinuria, microalbuminuria levels) in patients with diabetes.

Anesthesia Considerations

Anatomic and functional differences in obese patients affect patient positioning and anesthesia management. Positions that restrict chest and abdominal excursion and compromise ventilation (ie, Trendelenburg, lithotomy, prone) generally are poorly tolerated by obese patients. The prone position may be well tolerated if the upper chest and pelvis are adequately supported to ensure free abdominal movement. For induction of general anesthesia, obese patients should be positioned with pillows or towels under the shoulders, with the head and upper body elevated in a semirecumbent position. If feasible, obese patients should be allowed to position themselves on the operating table while they are awake.[16]

Anatomic features that affect anesthesia management include limited movement of the atlantoaxial joint and cervical spine; a short, thick neck; suprasternal, presternal, and posterior cervical fat; a thick submental fat pad; and excessive tissue folds in the mouth and pharynx. Functional differences include decreased residual volume, worsened ventilation-perfusion mismatch, increased atelectasis, and decreased functional residual capacity.[16]

Obstructive sleep apnea also complicates anesthesia because of complete or partial closure of the pharyngeal airway, cortical arousal, and oscillations in blood gas values. These anatomic and functional features of obese patients lead to difficulties in mask ventilation and intubation; awake intubation with a fiberoptic bronchoscope generally is preferred because it allows spontaneous ventilation, maintains parapharyngeal tone, and allows clearance of secretions. If difficulties with mask ventilation or intubation are anticipated, other anesthetic methods may be considered. Predictors of difficult mask ventilation or intubation include a Mallampati score of class III or class IV (ie, III, soft palate, base of uvula visible; IV, only hard palate visible), limited mandibular protrusion, a mouth opening of <3 cm, a thyromental distance measurement of <6 cm, sleep apnea, and a BMI >25.[17]

Neuraxial anesthesia techniques (ie, spinal, epidural) minimally affect respiratory function and sleep patterns and may be used successfully in obese patients; however, sympathetic blockade can spread to higher levels in obese patients compared with patients of normal weight, and regional techniques may be more difficult to perform. A variety of peripheral nerve blocks may be used safely in obese patients, but these persons are nearly twice as likely to experience a failed block; in addition, blocks may be problematic because of difficulties in identifying appropriate landmarks. Intravenous anesthesia agents and adjuncts also may be used to provide total anesthesia or to supplement other anesthetic techniques, but the dosage must be carefully calculated according to total body weight, ideal body weight, or lean body weight, depending on the agent and the gender of the patient.[18]

Postoperative Considerations

Obesity is an independent risk factor for venous thromboembolism and pulmonary embolism; thus, mechanical and/or pharmacologic prophylaxis is recommended. Mechanical devices, such as compression stockings, venous foot pumps, and intermittent pneumatic compression devices, may be difficult to use in obese patients, although anti-embolism stockings and foot pumps are available in larger sizes. Pharmacologic deep vein thrombosis (DVT) prophylaxis may include low-molecular-weight heparin and oral anticoagulants, such as fondaparinux, dalteparin, and enoxaparin. Although studies suggest that the standard doses may be insufficient for obese patients,[19] no formal recommendations exist for weight-adjusted DVT prophylaxis. In a study by Davidson et al[19] that included >40,000 patients, nearly a third of whom had a BMI ≥30, current recommended doses of fondaparinux and heparin appeared to provide similar protection against DVT regardless of BMI. A once-daily 10-mg subcutaneous injection of fondaparinux was as safe and effective in obese patients as in patients of normal weight.

In a case-control study of patients who underwent TKA, the authors determined that severe obesity was not a notable independent predictor for venous thromboembolism and did not modify the beneficial effect of standard pharmacologic thromboprophylaxis;[20] bilateral TKA and failure to ambulate by the second day after surgery were significant risk factors. However, other investigators have found that a standard heparin infusion rate is ineffective in obese patients; infusion rates that are based on ideal body weight may underestimate heparin requirement, and infusion rates that are based on actual body weight may provide too much heparin.[21] Although weight-based dosage adjustments for morbidly obese patients have not been established by prospective randomized trials, use of higher than standard dosages of enoxaparin and unfractionated heparin in obese patients have been associated with notably fewer DVT complications without an increase in bleeding complications. Current American College of Clinical Pharmacy guidelines document that higher than standard doses or weight-based doses should be considered, and therapy should be monitored using anti-factor Xa levels.

Outcomes of Orthopaedic Procedures in Obese Patients

Increased BMI in the absence of comorbidities (ie, simple obesity) does not appear to significantly increase the risk of adverse postoperative outcomes compared with outcomes in patients of normal weight,[8] with the exception of venous thromboembolism; in fact, obesity has been associated with lower morbidity and mortality in the general surgery literature. However, obese patients with metabolic syndrome have been found to be at a substantially higher risk of complications.[5] Outcomes of specific orthopaedic procedures have been mixed, and no consensus exists on the exact BMI or comorbidity that definitely indicates a likelihood of a poor outcome.

Total Joint, Knee, and Hip Arthroplasty

Although obese patients have been shown to have notably higher rates of complications, especially infection, after total joint arthroplasty than do patients of normal weight,[22] many studies have found similar clinical outcomes after TKA and total hip arthroplasty (THA),[23,24] although recovery may be slower. Obese and even super-obese (ie, BMI >50) patients actually have more improvement in function than do patients of normal weight,[25,26] possibly because their preoperative function was much less than that of their non-obese counterparts. In a retrospective analysis of nearly 2,000 total joint arthroplasties, Suleiman et al[24] found no differences in perioperative complications between obese patients and patients of normal weight. However, the Workgroup of the American Association of Hip and Knee Surgeons Evidence-Based Committee determined from their literature review that all obese patients (ie, BMI >30) appear to be at risk for an increasing number of perioperative complications after total joint arthroplasty (TJA), especially with poorly controlled comorbidities.[27] Implant survival times also are similar,[28] although some clinicians reported significantly lower implant survival times in morbidly obese patients and more technical errors in obese patients. Dislocation also occurs more frequently after THA in obese patients.[29] Whether obesity results in the use of more hospital resources and higher costs remains unclear; some clinicians cite longer surgical times, longer hospital stays, and use of more hospital resources for obese patients;[30] other clinicians report no notable difference between obese patients and patients of normal weight.[31]

Whereas most surgeons do not recommend limiting access to TJA for obese patients, McElroy et al,[23] after a systematic review of the literature, showed lower implant survival and worse outcomes in morbidly obese patients after TKA and suggested a BMI of 40 as a cutoff to help guide decision-making. Amin et al[32] recommended that patients with a BMI ≥40 be advised to lose weight before TJA and be counseled about the possible complications and inferior results that may occur if they do not lose weight. The Workgroup of the American Association of Hip and Knee Surgeons reached a similar conclusion, recommending patient counseling before surgery because morbidly obese (ie, BMI >40) and super-obese (BMI >50) patients have complication profiles that may outweigh the functional benefits of TJA. The consensus of the work group was that a delay in TJA should be considered in patients with a BMI >40, especially when comorbid conditions are present.[27]

Because of a perceived association between obesity and inactivity caused by joint pain, TJA often is suggested to help patients lose weight; however, most patients do not lose weight after THA or TKA.[33]

Ankle and Shoulder Arthroplasty

Information is scarce concerning the effect of obesity on ankle and shoulder arthroplasty. The information that is available appears to reinforce the basic findings in TKA and THA: obese patients have more complications, but most patients have significant reductions in pain and disability after total ankle[34] or total shoulder arthroplasty.[35]

Spine Surgery

Reports of outcomes of spine surgery in obese patients are similar to TJA outcomes, with studies reporting increased complications, especially infection, in obese patients[36] and fewer reports of no increased complications.[37] Although functional outcome scores in obese patients may not be as positive as scores in patients of normal weight, obese patients do have high levels of satisfaction and self-rated improvement after spine surgery;[38] in fact, the treatment effect may be greater in obese patients. Technical aspects of surgery, such as pedicle screw placement, are more difficult in obese patients; however, minimally invasive techniques appear to obtain similar good outcomes with similar rates of complications in obese patients and patients of normal weight.[39] Mehta et al[40] suggested that the thickness of subcutaneous fat is a better predictor of infection after both cervical and lumbar fusions than is BMI. The general consensus is that obese patients can benefit from spine surgery, even with increased complications; however, as with TJA, there are no guidelines for determining the upper limit of BMI at which spine surgery should be avoided.

Retrospective studies have shown that obesity increases the rate of intraoperative and postoperative complications of spine surgery in children and adolescents[41] and makes bracing difficult.[42]

Trauma

Treatment of traumatic injuries in obese patients is difficult because of altered immune and metabolic responses to trauma, resulting in higher rates of multi-organ failure and acute respiratory distress syndrome,[43] higher infection rates, longer intensive care unit and hospital stays, increased cost, and an increased risk of morbidity and mortality.[44] Because end-organ dysfunction patterns may be different in obese patients than in lean patients, liver dysfunction should be carefully monitored.[45] Resuscitation often is inadequate in obese patients when it is based on traditional end points,[45] and glycemic control is especially important in obese trauma patients. The size of obese patients also presents difficulties in imaging, positioning on a fracture table, and implant selection.

Obese patients with knee dislocations, usually from low-velocity trauma, are more likely to have nerve and vascular injuries that require repair, and complications are more frequent. Although morbid obesity complicates surgical management of ligament injuries associated with a knee dislocation, surgical treatment can improve both subjective and objective results in obese patients. Several studies identified obesity as a notable factor in the development of infection after pelvic or acetabular surgery,[46,47] and obese patients with a proximal humeral fracture or lower extremity fractures are likely to recover more slowly and require care in a short-term facility. In a study of the effect of obesity on pediatric fracture management, Backstrom et al[9] reported that obese children had more severe lower extremity fractures, resulting in more frequent admissions to the intensive care unit, than did children of normal weight, and the children were more likely to die in the hospital. In a prospective study of nearly 300 children with long-bone fractures, Lee et al[48] reported that obese children did not have a delay in release to activities compared with children of normal weight.

Doctors' Perceptions of Obese Patients

Although orthopaedic surgical interventions performed on obese patients have higher complication rates, these procedures may offer notable improvements in pain and function. The challenges encountered in diagnostic modalities, anesthesia, operating room equipment, surgical instrumentation, and postoperative care can be met with careful planning and ingenuity. Preoperative measures can be taken to minimize the effects of medical comorbidities.

The biggest obstacle to optimal orthopaedic care of obese patients is not the patient's body habitus but the attitude of the physician. Anti-obesity bias is pervasive among physicians. Fifty-three percent of patients reported inappropriate comments made by physicians about their weight.[49] Healthcare is compromised by the reluctance of obese patients, especially women, to be weighed or examined by a physician, fearing that the physician will be quick to blame their symptoms on their weight. This apprehension is not unfounded; weight bias is greater among men, especially toward women.[49] As physicians, we must examine our own biases and make a conscious effort to prevent these biases from interfering with patient care.

Summary

Obesity is an increasingly common condition among patients with orthopaedic conditions and procedures. It is a factor in several comorbidities, such as obstructive sleep apnea, diabetes, cardiovascular disease, and metabolic syndrome, that complicate the treatment of overweight and obese patients and require specific preoperative, intraoperative, and postoperative modifications. Increased complications in obese patients compromise outcomes, but orthopaedic interventions can still provide notable improvements in quality of life for even super-obese patients. No upper BMI limit has been established beyond which orthopaedic surgery is contraindicated, and each patient should be considered individually. Overweight or obese patients should be counseled about the added risks of surgery and offered resources for weight loss before surgery.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, reference 31 is a level I study. References 1, 2, 11, 17, 22, 35-37, 39, 44, 47, and 48 are level II studies. References 3, 8, 12-15, 21, 24, 25, 33, 34, 38, 40, 43, 45, and 46 are level IV studies. References 4, 16, 18, and 42 are level V expert opinion. Reference 28 is a biomechanical study, and reference 49 is a survey-based report.

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