Obesity has become a major issue facing the world’s population, and for the first time in human history rivals malnutrition as the most important nutritional disorder facing humanity. In the United States the obesity epidemic continues to grow, and has become an issue of significant public health concern. Pediatric obesity is particularly important because it is developing faster than obesity that begins in adulthood. It is also associated with an early onset of obesity related diseases such as hypertension and cardiovascular disease, and is frequently a precursor to significant and intractable adult obesity. In this brief essay I will review the following:

1. The Epidemiology of Obesity
2. The Biology of Weight
3. Multidisciplinary Approach to Bariatric Surgery in Adolescents
4. Anesthetic Implications of Bariatric Surgery

**Epidemiology of Obesity**

The prevalence of pediatric obesity in the United States, defined as >95th percentile BMI for age, has tripled over the past thirty years, increasing from 5% in the 1960’s to 16% in the late 1990’s. Obesity rates are even higher in minority children and children raised in poverty. Obesity can be measured in a variety of ways, most commonly as the Body Mass Index (BMI), defined as weight in kilograms divided by height in meters squared. While not a perfect measurement of adiposity, BMI is easily calculated and is well correlated with both morbidity and mortality. Accuracy of pediatric obesity measurement is confounded by the rapid linear and weight changes associated with childhood and adolescence. Nonetheless, age and height curves for BMI in children provide a reasonable estimate of fatness.

The U.S. Center for Disease Control has defined “overweight” in adults as a BMI between 25 and 30 and “obese” as a BMI over 30. Children “at risk for overweight” are children with weights between the 85th and 95th percentile for age, and “overweight” children have weights greater than the 95th percentile for age. At the present time 5-10% of adolescents have a BMI of >40, which makes severe pediatric obesity more common than cystic fibrosis, juvenile diabetes, HIV, and childhood cancers combined.

In adults, management of weight problems has been frustrating because the vast majority of dieters will ultimately regain the weight they have lost. In children, the likelihood that an overweight individual will become an obese adult increases as the child ages, peaking at about 70% for obese adolescents. Weight loss is less likely as the degree of adiposity rises, resulting in a very low probability that the most severely obese teenager will be able to successfully lose weight.
As a result of these statistics bariatric surgery is emerging as a means of addressing the most extreme cases of adolescent obesity. Bariatric surgical procedures are designed to either limit the size of the stomach or bypassing some length of the small bowel to diminish caloric absorption. The Roux-en-Y gastric bypass has emerged as the most commonly performed surgical procedure for obesity in the United States. In 2003 almost 103,000 procedures of this type were performed on obese American adults.

**The Biology of Weight**

While most obesity is due to the combination of excessive caloric intake and inadequate expenditure of calories, interesting data has emerged during the past decade that indicate that weight gain and loss involve a complex and poorly understood biological regulatory system. Like other diseases such as diabetes, hypertension and stroke, genetic susceptibility and environmental forces frequently combine to provide an appropriate setting for the expression of obesity and its associated pathology. It is now known that several hormones influence hunger and satiety through the hypothalamus, and that fat is a hormonally active tissue.

Research has demonstrated that our weights are regulated around a “set point” and that our bodies try to defend that set point vigorously. For instance, weight loss is associated with increased hunger and a decreased metabolic rate. This may be why we find it is sometimes easy to lose a few pounds, but continued weight loss is difficult despite our continued caloric restriction. Unfortunately, increasing fat mass appears to have a weaker feedback loop so that weight gain is usually much easier than weight loss.

Insights into the mechanisms of weight homeostasis are gained as scientists look at unusual cases of individuals with rare genetic abnormalities that illustrate the biological underpinnings of why we gain weight.

Several hormones are now known to influence our eating behavior, such as leptin, ghrelin, and melanocortin 4. One example of a monogenic mutation that is associated with weight gain is that of the melanocortin 4 receptor (MC4R). Recent evidence has demonstrated that up to 6% of children with severe early onset childhood obesity have functionally important mutations of this gene, making MC4R the most common monogenic abnormality associated with obesity. Carriers of the MC4R mutations typically have hyperphagia, hyperinsulinemia, and rapid linear growth rates compared to controls. Other monogenic mutations of interest include that of leptin. This hormone is secreted by adipose tissue and seems to provide feedback about our fat stores to the hypothalamus, resulting in appetite suppression. In three interesting children with congenital leptin deficiency, extreme hyperphagia resulted in massive obesity at an early age (in one case requiring liposuction at age 6 to improve her mobility and osteotomies for obesity induced valgus deformities of the legs). These children responded dramatically to exogenous administration of leptin, resulting in an immediate dramatic decrease in food intake and weight loss. Unfortunately, experimental use of exogenous leptin in other obese patients has been less successful.
Most obesity is also strongly environmentally influenced, and genetic input is likely polygenic in nature. These interesting monogenic cases nonetheless provide insights into the control of appetite and weight, and may provide leads into potential avenues of pharmacologic management of weight in the future.

**Multidisciplinary Approach to Bariatric Surgery in Adolescents**

Healthworks! is a multidisciplinary program at the Cincinnati Children’s Hospital designed to address the needs of overweight children and adolescents. This physician-supervised interventional weight management program brings together pediatricians, dieticians, physical therapists, and psychologists in an effort to tackle the difficult problem of childhood obesity. To address the needs of patients with severe obesity that is refractory to behavioral treatment and is associated with significant comorbidities, bariatric surgery has been incorporated into the program.

A successful bariatric program for adolescents requires the participation of many pediatric subspecialists including surgeons familiar with bariatric procedures, anesthesiologists, endocrinologists, gastroenterologists, cardiologists, pulmonologists, and others.

We utilize a highly selective process for adolescent patients who wish to explore bariatric surgery. Patients must have failed at least six months of an organized attempt at weight management, and must be at, or close to, physical maturity to be considered for this type of intervention. Patients must also have a BMI of >40 with severe comorbidities, or >50 with less severe comorbidities. The Cincinnati Children’s Hospital Bariatric Team has defined severe complications of obesity as type 2 diabetes mellitus, obstructive sleep apnea, or pseudotumor cerebri. Other criteria for this surgery include a commitment to comprehensive medical and psychological evaluation prior to surgery, as well as a commitment to lifelong follow-up. Patients must be able and willing to adhere to significant postoperative nutritional guidelines, and have an appropriately supportive family environment. Ultimately it is the bariatric team that on a case-by-case basis should determine the appropriateness of surgical intervention.

**Anesthetic Implications of Obesity in Adolescents**

The medical risks associated with adult obesity, such as diabetes, hypertension, dyslipidemias, cardiovascular disease, certain types of cancer, gout, and arthritis are well documented. Recent evidence has shown that obesity in the pediatric population is not benign. Many pathological states, such as hypertension and left ventricular hypertrophy (LVH), can be identified in the obese child, and our task as anesthesiologists is to identify those comorbidities that will interfere with a smooth perioperative course. Every adolescent scheduled for bariatric surgery undergoes a preoperative consultation with the Department of Anesthesia.

Obesity in children is now known to be associated with early pathologic cardiovascular changes. Hypertension, previously seen most frequently in children with renal disease, is increasingly identified in obese children. Work by Steve Daniels in Cincinnati and others have shown that there is a three fold higher risk of hypertension in obese children, and that the risk of hypertension increases as BMI rises. The Bogalusa Heart Study, a large long-term prospective study on child health, identified cardiac risk factors in obese children as young as five to ten years of age, including hypercholesterolemia, hypertension and hyperinsulinemia. LVH has
been identified in obese children as young as ten years of age, and is commonly seen in adolescents presenting for bariatric surgery. Research is underway to determine if changes in cardiac architecture are reversible with weight loss.

Dosing of drugs and choice of anesthetic agent is critical in providing a safe perianesthetic course. Drugs should be dosed according to “ideal” body weight rather than actual body weight. Lean body mass does increase to some extent in the morbidly obese, but probably peaks at about 100 kilograms in the largest patient. Anesthetic vapors with low blood-gas solubilities are ideal in this setting. Rapid emergence from anesthesia is appropriate for this patient population, and can be facilitated with agents such as desflurane or sevoflurane.

Patients with morbid obesity will frequently present with obstructive sleep apnea (OSA), many of whom require continuous positive airway pressure (CPAP) at night. Post operative management of these patients can be complicated by their use of CPAP, as our surgeons wish to minimize pressure on the new gastrojejunostomy in the immediate post operative period. We will typically try to not use CPAP immediately after surgery, and have found that this has been well tolerated.

Concern about airway management in the obese patient is appropriate but is probably less important than earlier thought. Some past studies in obese adults identified as many as ten percent of patients with difficult airway management. We have found that the vast majority of patients have been easily managed with simple precautions. We build up the operating room bed such that patients are in a ramped position during induction, and thorough preoxygenation is mandated. We will typically perform a rapid sequence induction with cricoid pressure. In our first forty-eight adolescent patients who have undergone bariatric surgery we have found that 95% had a Cormack and Lehane score of 1 and 5% had a score of 2. No patient to date has required further airway intervention with a laryngeal mask airway or fiberoptic bronchoscope. All patients have been extubated in the operating room.

Patients who have undergone laparoscopic gastric bypass are managed with patient controlled analgesia pumps in the postoperative period. Uncomplicated patients are usually discharged home on postoperative day three.

References


