Bariatric Surgery for Severely Overweight Adolescents: Concerns and Recommendations

Thomas H. Inge, MD, PhD*; Nancy F. Krebs, MD‡; Victor F. Garcia, MD*; Joseph A. Skelton, MD§; Karen S. Guice, MD‖; Richard S. Strauss, MD¶; Craig T. Albanese, MD#; Mary L. Brandt, MD**; Lawrence D. Hammer, MD‡‡; Carol M. Harmon, MD, PhD§§; Timothy D. Kane, MD‖‖; William J. Klish, MD¶¶; Keith T. Oldham, MD##; Colin D. Rudolph, MD§; Michael A. Helmrath, MD**; Edward Donovan, MD***; and Stephen R. Daniels, MD, PhD***

ABSTRACT. As the prevalence of obesity and obesity-related disease among adolescents in the United States continues to increase, physicians are increasingly faced with the dilemma of determining the best treatment strategies for affected patients. This report offers an approach for the evaluation of adolescent patients' candidacy for bariatric surgery. In addition to anthropometric measurements and comorbidity assessments, a number of unique factors must be critically assessed among overweight youths. In an effort to reduce the risk of adverse medical and psychosocial outcomes and increase compliance and follow-up monitoring after bariatric surgery, principles of adolescent growth and development, the decisional capacity of the patient, family structure, and barriers to adherence must be considered. Consideration for bariatric surgery is generally warranted only when adolescents have experienced failure of ≥6 months of organized weight loss attempts and have met certain anthropometric, medical, and psychologic criteria. Adolescent candidates for bariatric surgery should be very severely obese (defined by the World Health Organization as a body mass index of ≥40), have attained a majority of skeletal maturity (generally ≥13 years of age for girls and ≥15 years of age for boys), and have comorbidities related to obesity that might be remedied with durable weight loss. Potential candidates for bariatric surgery should be referred to centers with multidisciplinary weight management teams that have expertise in meeting the unique needs of overweight adolescents. Surgery should be performed in institutions that are equipped to meet the tertiary care needs of severely obese patients and to collect long-term data on the clinical outcomes of these patients. ***Pediatrics*** **2004;114:217–223;** ***bariatric surgery, gastric bypass, adjustable gastric band, adolescence, obesity, overweight.***

ABBREVIATIONS. BMI, body mass index; AGB, adjustable gastric banding.

In the past 30 years, the prevalence of overweight among pediatric age groups in the United States has almost tripled. Current conservative estimates indicate that 15.5% of children and adolescents are obese (body mass index [BMI] of ≥95th percentile for age).[1] The health consequences of this epidemic are enormous, and the burdens on our health care system are rapidly increasing. Annual hospital costs for obesity-related diagnoses in the pediatric population increased 3-fold between 1979–1981 and 1997–1999.[2] For adults, the economic burden of obesity on the health care system in 2002 was estimated as $93 billion.[3]

Studies show that 50% to 77% of children and adolescents who are obese carry their obesity into adulthood, thus increasing their risks of developing serious and often life-threatening conditions. The risk increases to 80% if just 1 parent is also obese.[4–8] Conditions frequently associated with severe obesity include premature death, heart disease, obstructive sleep apnea, hypertension, dyslipidemia, and type 2 diabetes mellitus,[4,9–13] which has significant and well-documented cardiac, renal, and ophthalmic complications for young adults.[14] Other serious conditions include pseudotumor cerebri, steatohepatitis, slipped capital femoral epiphysis, Blount's disease, cholelithiasis, polycystic ovary syndrome, and early severe degenerative joint disease.[15,16] It is also noteworthy that reported quality of life scores for obese children were significantly lower than those for children of normal weight.[17]

Excessive weight gain is influenced by genetic, environmental, and biologic factors.[18,19] Reversing the current trend will require a multifaceted approach and coordinated research efforts aimed at identifying optimal treatment strategies. Until such

From the Departments of *Pediatric Surgery and ***Pediatrics, Cincinnati Children's Hospital Medical Center, University of Cincinnati, Cincinnati, Ohio; ‡Section of Nutrition, Department of Pediatrics, University of Colorado Health Sciences Center, Denver, Colorado; §Division of Pediatric Gastroenterology and Nutrition, Department of Pediatrics, ‖Department of Surgery, and ##Division of Pediatric Surgery, Children's Hospital of Wisconsin, Medical College of Wisconsin, Milwaukee, Wisconsin; ¶Johnson & Johnson Pharmaceutical Research and Development, Titusville, New Jersey; #Division of Pediatric Surgery, Department of Surgery, Lucile Packard Children's Hospital, and ‡‡Department of Pediatrics, Stanford University Medical Center, Stanford, California; **Division of Pediatric Surgery, Michael E. DeBakey Department of Surgery, and ¶¶Division of Gastroenterology and Nutrition, Department of Pediatrics, Baylor College of Medicine, Houston, Texas; §§Division of Pediatric Surgery, Children's Hospital of Alabama, University of Alabama at Birmingham, Birmingham, Alabama; and ‖‖Division of Pediatric Surgery, Department of Surgery, Children's Hospital of Pittsburgh, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania.

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Reprint requests to (T.H.I.) Comprehensive Weight Management Center, Department of Pediatric Surgery, Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave, MLC 2023, Cincinnati, OH 45229. E-mail: thomas.inge@cchmc.org

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progress is made, physicians will be confronted with increasing numbers of young patients with serious consequences of obesity. For severely overweight adolescents who have failed organized attempts to lose weight and/or to maintain weight loss through conventional nonoperative approaches and who have serious or life-threatening conditions, bariatric surgery may provide the only practical alternative for achieving a healthy weight and for escaping the devastating physical and psychologic effects of obesity.

As the need for a surgical weight loss option for younger patients becomes evident, physicians are faced with the task of delineating clear, realistic, and restrictive guidelines for using this aggressive approach. Because of the recognized long-term deleterious effects of obesity, bariatric surgery is commonly performed for adults with BMI values of ≥35 with comorbidities and for adults with BMI values of ≥40 with or without comorbidities, as suggested by 1991 National Institutes of Health consensus conference guidelines.[20] Simple adoption of these guidelines for use in younger age groups would overlook the unique metabolic, developmental, and psychologic needs of adolescents and could result in the inappropriate use and/or overuse of weight loss surgery for adolescents. More conservative patient selection criteria should be considered for adolescents also because: although many comorbidities of obesity can be documented in childhood and adolescence, the severity of these complications for the majority of obese (BMI ≥ 30) adolescents does not warrant surgical intervention for minors, who by legal statute cannot give their own consent for the procedure; behavioral therapy approaches to weight management have been demonstrated to be more effective for children and adolescents than adults;[21] a proportion (20–30%) of obese adolescents may not be destined to become obese adults;[5] and there are few data for adults and no data for adolescents suggesting that surgical weight loss improves the early mortality suffered by subjects with severe obesity. For these reasons, in general, surgery should be reserved for very severely obese adolescents with comorbidities, after careful deliberation.[22]

In light of these considerations, a group of surgeons and pediatricians specializing in the treatment of overweight and obese children recently met to consider relevant concerns. This article represents the consensus reached by participants at that meeting, on the basis of their current knowledge and clinical practice. The key issues discussed include patient evaluation and selection, surgical treatment, and long-term follow-up monitoring.

PATIENT EVALUATION

BMI (weight in kilograms divided by height in meters, squared) is a useful screening tool for assessing and tracking the degree of obesity among adolescents.[23,24] Medical evaluations should include investigation into possible endogenous causes of obesity that may be amenable to treatment and identification of any obesity-related health complications. Likely candidates for bariatric surgery should be referred to centers with multidisciplinary weight management teams experienced in meeting the distinct physical and psychologic needs of adolescents. These teams should include specialists with expertise in adolescent obesity evaluation and management, psychology, nutrition, physical activity instruction, and bariatric surgery. Surgeons participating in multidisciplinary adolescent bariatric teams should undergo subspecialty training in bariatric medical and surgical care, as detailed by the American College of Surgeons and the American Society for Bariatric Surgery. The importance of proper training and experience in bariatric surgery to ensure safe and effective application of this intervention in the adolescent population cannot be understated.

Additional expertise in adolescent medicine, endocrinology, pulmonology, gastroenterology, cardiology, orthopedics, and ethics should be readily available. The team approach should include a review process (patient review board) similar to that used in multidisciplinary oncology and transplant programs. This review should result in specific treatment recommendations for individual patients, including the appropriateness and timing of possible surgical intervention.

In addition to undergoing medical assessments, potential candidates should undergo comprehensive psychologic evaluations involving both patient and parent interviews, to facilitate assessment of the family unit, determination of the coping skills of the adolescent, and assessment of the severity of psychosocial comorbidities. These evaluations may inform the team of family strengths or family dysfunction that could have significant effects on the overall success of bariatric surgery, because of the influence of the family environment on postoperative regimen adherence.

The most important ethical issues when considering an adolescent for a bariatric procedure are whether the patient's health is being compromised by severe obesity, whether the patient has failed more conservative options to meet that health need, and whether the patient has decisional capacity. Decisional capacity is not determined strictly by chronologic age, but many would agree that children <13 years of age usually do not have the capacity to make decisions regarding such a complicated serious intervention. At ≥13 years of age, adolescent patients, if developmentally normal, may be able to make informed decisions. The responsibility then falls on health care professionals to make the argument for or against that capacity for any given patient. When there are questions about decisional capacity, specialists in pediatric psychiatry or psychology can assist in determining decisional capacity or competency (the legal term). Patients with decisional capacity should be allowed to participate in self-determining decisions. However, the younger the patient, the more compelling and serious the comorbidity of obesity should be to prompt surgical intervention (Table 1).

In the presence of certain circumstances or medical conditions, bariatric surgery is not a realistic treatment option. These conditions include a medically correctable cause of obesity; a substance abuse prob-

TABLE 1. Obesity-Related Conditions That May Be Improved With Bariatric Surgery

Serious comorbidities
Type 2 diabetes mellitus
Obstructive sleep apnea
Pseudotumor cerebri
Less serious comorbidities
Hypertension
Dyslipidemias
Nonalcoholic steatohepatitis
Venous stasis disease
Significant impairment in activities of daily living
Intertriginous soft-tissue infections
Stress urinary incontinence
Gastroesophageal reflux disease
Weight-related arthropathies that impair physical activity
Obesity-related psychosocial distress

lem within the preceding year; a medical, psychiatric, or cognitive condition that would significantly impair the patient's ability to adhere to postoperative dietary or medication regimens; current lactation, pregnancy, or planned pregnancy within 2 years after surgery; and inability or unwillingness of either the patient or the parents to fully comprehend the surgical procedure and its medical consequences, including the need for lifelong medical surveillance.

PATIENT SELECTION

In the absence of strong clinical evidence supporting the long-term efficacy and safety of bariatric surgery among adolescents, patient selection for surgical treatment requires consideration of a number of factors (Table 2) and careful clinical judgment by the multidisciplinary bariatric team. Certain comorbidities of obesity may be considered serious and progressive and may respond well to surgical weight loss. Among patients with very severe obesity (BMI $\geq$ 40), the presence of a serious comorbid condition (Table 1) should prompt consideration for evaluation by a bariatric team. Bariatric surgery also should be considered an appropriate option for adolescents with higher BMI values (perhaps $\geq$50) with less serious obesity-related comorbid conditions (Table 1) if the conditions can be predictably corrected with surgical weight loss and if the short- and long-term risks of not operating are thought to be greater than those associated with surgery. It is important to recognize that no clinical algorithm can be rigidly applied to all patients; some conditions in the less serious category may be quite severe and compelling indications for bariatric surgical intervention for individual patients with BMI values that are not $\geq$50. The clinical judgment of the bariatric team should determine the appropriateness of surgical intervention for individual patients. Adolescent patients must also be highly motivated and capable of understanding the lifestyle changes that are necessary, as well as the risks, side effects, and lifelong need for medical surveillance.

TABLE 2. Criteria for Bariatric Surgery

Adolescents Being Considered for Bariatric Surgery Should:
Have failed $\geq$6 months of organized attempts at weight management, as determined by their primary care provider
Have attained or nearly attained physiologic maturity
Be very severely obese (BMI $\geq$ 40) with serious obesity-related comorbidities or have a BMI of $\geq$ 50 with less severe comorbidities
Demonstrate commitment to comprehensive medical and psychologic evaluations both before and after surgery
Agree to avoid pregnancy for at least 1 year postoperatively
Be capable of and willing to adhere to nutritional guidelines postoperatively
Provide informed assent to surgical treatment
Demonstrate decisional capacity
Have a supportive family environment

SURGICAL TREATMENT

Optimal Timing

The timing of surgical treatment of clinically severe obesity among adolescents is controversial and often depends on the severity of obesity-related comorbidities for individual patients. Neuroendocrine, skeletal, and psychosocial maturation are accelerated during adolescence, and it is not yet known how these processes are affected by restrictive or malabsorptive surgical procedures. The rapid somatic growth observed in early adolescence requires adequate nutrition; therefore, bariatric procedures performed before the growth spurt could potentially compromise linear growth. Physical examinations should include evaluations of sexual maturation, because the linear growth spurt generally occurs before Tanner stage IV for both boys and girls. The majority of skeletal maturity is attained for girls by $\geq$13 years and for boys by $\geq$15 years of age.

These ages may well represent conservative estimates of skeletal maturation, because overweight children experience an early onset of puberty and are likely to achieve skeletal maturity (adult stature) earlier in adolescence, compared with age-matched, nonoverweight children. When there is uncertainty regarding whether adult stature has been attained, bone age can be objectively assessed with radiographs of the hand and wrist. If an individual has attained $\geq$95% of adult stature, according to the results of this examination, then there is little concern that a bariatric procedure may significantly impair completion of linear growth. It is unknown, however, whether and to what extent bariatric surgery may affect bone mineral density adversely and increase the risk of brittle bone fractures later in life. Finally, although many severely obese adolescents may be deemed physiologically mature, psychologic readiness for a bariatric surgical intervention is less readily assured.

Informed Permission

Assent for surgery must be obtained from the adolescent patient, whereas informed permission must be obtained from the responsible parents or guardians before surgery. Both patients and parents must be made aware of the fact that bariatric surgery is a procedure with considerable risks, including the risk of death. Although bariatric procedures can result in substantial weight loss, the long-term metabolic, nutritional, and psychologic effects among adolescents are unknown. Similarly, patients and parents must understand that the durability of surgically induced weight loss among adolescents remains to be clearly defined.

Preoperative Education

An important element of long-term health and weight loss success is the development of an integrated multidisciplinary education program. Such a program must be aimed at teaching both parents and patients about the anatomic and physiologic features of the proposed surgery and the lifelong need for strict adherence to nutritional guidelines and daily physical activity and offering behavioral strategies to meet these needs. Attendance at adolescent bariatric support group meetings before and after surgery can also be quite helpful.

Laboratory and Radiologic Investigations

Several studies should be considered when candidacy for bariatric surgery is contemplated. These studies may identify conditions that may affect perioperative decision-making or may identify obesity-related comorbid conditions that may justify surgical intervention. These studies include fasting glucose and hemoglobin A1C measurements, liver function tests, lipid profile tests, complete blood counts, thyroid function tests, pregnancy tests for female patients, and screening for micronutrient deficiencies. For patients with symptoms of obstructive sleep apnea, polysomnography is suggested. Finally, bone age assessment should be considered for younger patients, to document the degree of skeletal maturity.

Choice of Surgical Procedure

There is currently a paucity of data comparing the efficacy and safety of various bariatric procedures among adolescents. However, both Roux-en-Y gastric bypass[25–33] (Fig 1) and adjustable gastric banding (AGB) (Fig 2)[34] have been effective in treating the medical consequences of severe obesity in adolescence.

The literature pertaining to adult bariatric surgery indicates both advantages and disadvantages of these procedures. The advantages of gastric bypass among adults include substantial loss of weight (33% reductions in body weight or BMI 1 year after surgery are typical) that is largely sustainable for up to 14 years, inherent deterrence to carbohydrate ingestion, and enhanced satiety after surgery. A greater risk of perioperative (within 30 days after surgery) death with gastric bypass (0.5%), compared with AGB (0.05%), has been documented among adults.[35] Potential complications of bypass include intestinal leakage, thromboembolic disease, small bowel obstruction, incisional hernia, symptomatic cholelithiasis, protein calorie malnutrition, and micronutrient deficiencies, especially of iron, calcium, and vitamin B_{12}.

Although data for adolescents are limited, the largest study in the literature reported on 33 adolescents who underwent various forms of gastric bypass (and 3 patients who underwent gastroplasty) between 1981 and 2001.[27] Although significant weight reduction was observed overall, 5 patients in the series regained some or all of their body weight 5 to 10 years after surgery. In that series, BMI values measured preoperatively, and at 1, 5, 10, and 14 years were 52, 36, 33, 34, and 38, respectively. The authors noted that most comorbid conditions resolved at 1 year, with the exception of hypertension for 2 patients, gastroesophageal reflux for 2, and degenerative joint disease for 7. Early complications observed among adolescent bariatric patients have been similar to those observed among adults and have included pulmonary embolism, wound infections, stomal stenoses (requiring endoscopic dilation), dehydration, and marginal ulcers (medically treated). Late complications have included small-bowel obstruction, incisional hernias, and late weight regain in up to 15% of cases. Suboptimal vitamin intake[31] and micronutrient deficiencies[26] have also occurred among adolescents after gastric bypass, as reported for adults.[36] Finally, there have been 4 late deaths among adolescents, between 15 months and 6 years

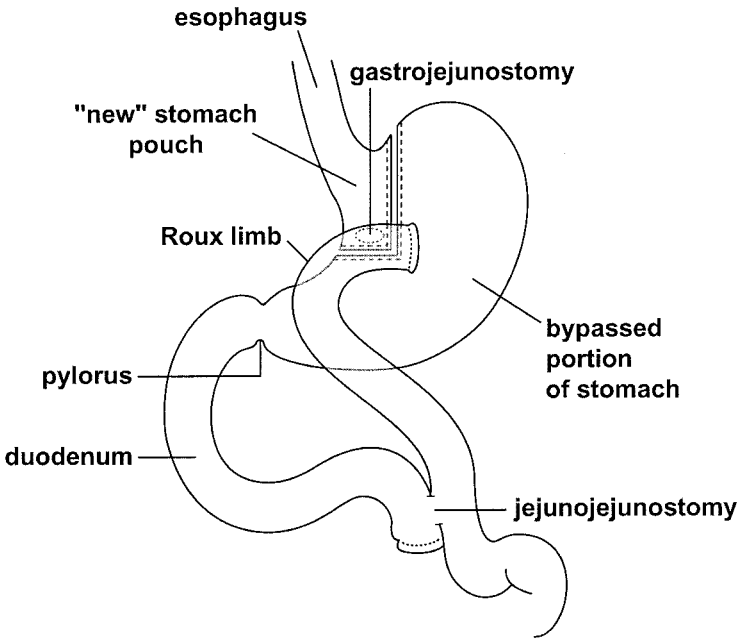

Fig 1. Roux-en-Y gastric bypass for treatment of clinically severe obesity.

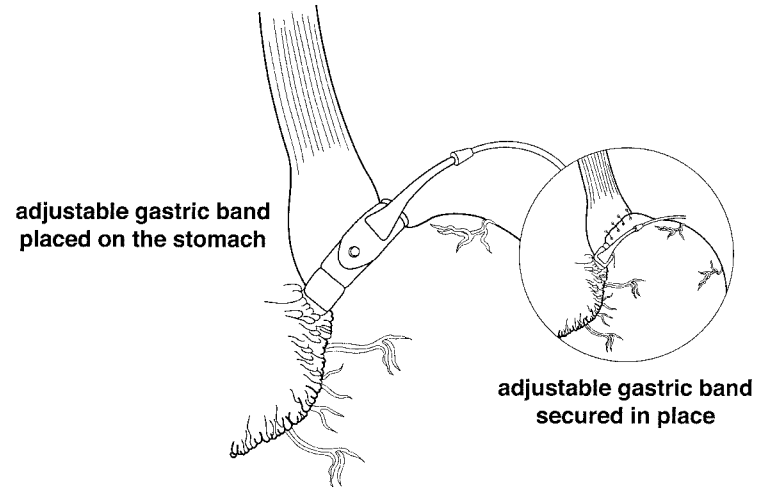

Fig 2. AGB.

after bariatric surgery; these deaths were thought to be unrelated to the surgical procedure.[25,27] Of the complications, late weight regain and inadequate vitamin and mineral intake most importantly underscore the necessity of a comprehensive team approach and long-term follow-up monitoring in this patient population.

AGB consists of laparoscopic placement of a silicone band that encircles the most proximal stomach, just beyond the gastroesophageal junction. The band is adjustable with injection of saline into a peripherally placed reservoir. The band is removable if necessary and, in most cases, has no significant adverse effect on esophagogastric anatomic features. Therefore, major advantages of AGB include the ease and safety of minimally invasive placement, adjustability, and reduced potential for adverse nutritional consequences.

There are a number of potential disadvantages of AGB. AGB has not been approved by the US Food and Drug Administration for use among patients <18 years of age, and very few insurance plans currently provide coverage for this device. Many[37–41] but not all[42] US studies have highlighted significant surgical complications and lesser degrees of weight loss with AGB, compared with gastric bypass. In the most experienced centers in Europe and Australia, where outcomes have been very good, generally patients have been monitored for <1 decade; therefore, long-term results of the procedure are not known.[43–45] Possible device-related complications include port malposition or malfunction, tubing leaks, band slippage leading to gastric prolapse, foreign-body infection, and band erosion into the stomach or esophagus. Moreover, because these mechanical devices have a finite lifetime, adolescent patients may need to undergo replacement of the device during their lifetimes. Although perioperative mortality risks and long-term nutritional risks are probably less than those noted with gastric bypass, AGB is similar anatomically to vertical-banded gastroplasty[46] and thus may not provide the same degree of durable, long-term weight loss as that expected after gastric bypass.

For all of these reasons, gastric bypass currently seems to be the most appropriate surgical option for most adolescents who are candidates for bariatric surgery; however, appropriately designed trials are needed to determine which surgical procedure is optimal for adolescents.

Postoperative Concerns

There are numerous postoperative concerns after bariatric surgery in adolescence. To avoid nutritional complications, patients must adhere to guidelines regarding diet and vitamin/mineral supplementation. Gastric bypass essentially results in surgically enforced, very low-calorie, low-carbohydrate dietary intake, thus requiring attention to adequate (≥0.5 g/kg) daily protein intake. Micronutrients, including calcium, vitamin B_{12}, folate, multivitamins, thiamine, and iron (for menstruating female subjects), must be supplemented after gastric bypass. A bariatric dietitian who is familiar with the progressive addition of food items with more complex compositions and consistencies can help with meal planning and nutritional "troubleshooting" as recovery proceeds. Finally, nonsteroidal antiinflammatory medications should be avoided, to reduce the risk of intestinal ulceration and bleeding.

Although pregnancies can be safely supported after bariatric surgery, reliable contraception should be used for at least the first 1 year after the operation, because of the increased risk to the fetus posed by the rapid weight loss. Iron deficiency anemia attributable to menstrual bleeding can also be minimized with oral contraception. After the period of rapid weight loss, pregnancies should be carefully planned and monitored.

LONG-TERM FOLLOW-UP MONITORING

Meticulous, lifelong, medical supervision of adolescent patients who undergo bariatric procedures is essential. During the first postoperative year, regular visits to the surgeon and other subspecialists with expertise in nutrition and obesity management (eg, psychologist, dietitian, and exercise physiologist) should be provided to identify potential complications and to reinforce compliance with required eating behaviors, administration of medications and

nutritional supplements, and physical activity regimens. Early hematologic or metabolic complications can be detected with periodic assessments of blood counts, blood chemistry profile, and body composition. Psychosocial adjustments during the postoperative period of rapid weight loss may present new unanticipated challenges for adolescent patients. The multidisciplinary team approach should minimize the adverse effects of these challenges as a healthier weight is achieved.

It is strongly recommended that all patients who undergo bariatric surgery be monitored throughout their lives, to ensure optimal postoperative weight loss, eventual weight maintenance, and overall health. This is particularly important for adolescents, given the fact that the long-term effects of bariatric surgery in younger, reproductively active populations have not been well characterized. Ideally, adolescents who undergo bariatric surgery should be treated consistently, at regional centers of excellence, with ongoing clinical data collection and targeted research. Our ability to make useful recommendations about the appropriate timing of bariatric surgery and optimal surgical and postoperative management depends on the collection of rigorous, high quality outcome data.

CONCLUSIONS

1. Surgical management may be warranted for very severely obese adolescents who have serious obesity-related comorbid conditions and who have, in the opinion of their primary care providers, experienced failure of organized attempts to achieve sustained weight loss.
2. Suggested criteria for surgical intervention (Tables 1 and 2) cannot be applied rigidly to every patient but should be tailored to the individual patient's needs, on the basis of the patient's maturity level and the severity of comorbid conditions.
3. A multidisciplinary team with expertise in adolescent weight management and bariatric surgery should carefully consider the indications, contraindications, risks, and benefits of bariatric surgery for individual patients.
4. It is essential for patients and their families to realize that bariatric surgery is not a cure for obesity but instead is an effective weight loss tool when patients comply with recommended dietary and physical activity regimens.
5. Patients and their families must fully understand the known risks and possible side effects of individual bariatric surgical procedures and should participate in decision-making.
6. Adolescent bariatric surgery should be performed only at facilities capable of treating adolescents with complications of severe obesity, where detailed clinical data collection can occur.
7. Highly trained and skilled bariatric surgeons must play an integral role within multidisciplinary adolescent bariatric teams, to ensure safe and effective application of bariatric surgical procedures for adolescents.

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