

Review

Bariatric surgery for extreme adolescent obesity: Indications, outcomes, and physiologic effects on the gut–brain axis

Stavra A. Xanthakos*

Surgical Weight Loss Program for Teens, Division of Gastroenterology, Hepatology and Nutrition, Cincinnati Children's Hospital Medical Center, Department of Pediatrics, University of Cincinnati, 3333 Burnet Avenue, MLC 2010, Cincinnati, OH 45229, USA

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Abstract

Objective: This review will summarize current indications, limitations and outcomes of bariatric surgery in adolescents, as well as provide an overview of the physiologic effects of bariatric surgery on enteric hormones involved in regulating appetite, satiation and maintenance of weight. **Results:** Extreme obesity (BMI $\geq$ 99 percentile) now affects 4% of children and adolescents in the United States. Traditional dietary and behavioral weight management methods have no demonstrated efficacy for extremely obese children and adolescents, in contrast with bariatric surgery which has produced significant and sustainable weight loss and associated improvements in comorbid diseases for the extremely obese. Roux-en-Y gastric bypass (RYGB) and laparoscopic adjustable gastric banding (LAGB) are the most commonly performed bariatric surgical procedures in adolescents, but vertical sleeve gastrectomy may be a promising new option for selected extremely obese adolescents. A mean weight loss of 37–40% is achieved in adolescents after RYGB, with LAGB showing similar results, albeit attained at a slower rate. **Conclusion:** Alterations in the enteric hormones involved in the gut–brain axis that regulates appetite and energy expenditure may play a role in both the anorexigenic and weight-reducing effects of certain bariatric surgical procedures. In particular, RYGB induces a rise in both fasting and post-prandial peptide tyrosine–tyrosine which could contribute to the more rapid and greater degree of weight loss than is seen with LAGB. Limitations of bariatric surgery however include the potential for post-operative morbidity and mortality, as well as possible weight regain in a small proportion of patients.

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Keywords: Obesity; Adolescent obesity; Bariatric surgery; Gastric bypass; Ghrelin; PYY; GLP-1

Contents

1. Introduction	136
2. Overview of bariatric surgery in adolescents	136
2.1. Indications	136
2.2. Surgical options for adolescents	136
2.3. Outcomes of bariatric surgery in adolescents	137
2.4. Complications of bariatric surgery in adolescents	138
3. Impact of bariatric surgery on gastrointestinal mediators of appetite and satiation	138
3.1. Ghrelin	139
3.2. The pancreatic polypeptide family: PYY _{3–36} and PP	140
3.3. The incretins: glucagon-like peptide 1, gastric inhibitory peptide and oxyntomodulin	141
3.4. Cholecystokinin	142
4. Conclusion	142
Acknowledgements	143
References	143

* Tel.: +1 513 636 4415; fax: +1 513 636 7805.

E-mail address: stavra.xanthakos@cchmc.org.

1. Introduction

Obesity has reached epidemic proportions in the United States and worldwide. In the last three decades, obesity prevalence in adults (defined as BMI ≥ 30 kg/m²) has doubled [1,2], while obesity prevalence (defined as BMI $\geq$ 95th percentile for age and gender) has tripled in adolescents age 12–19 [3]. Alarming, not only the prevalence but the severity of obesity has increased in both adults and children. Seven percent of women and three percent of men now have a BMI ≥ 40 kg/m² [1,2], while four percent of adolescents are extremely obese (defined as BMI $\geq$ 99th percentile) [4]. Ninety-four percent of children with a BMI $\geq$ 99th percentile have excess adiposity and thirty-three percent have three or more cardiovascular disease risk factors [4]. Longitudinal analysis of children with a BMI $\geq$ 99th percentile indicate that 100% remain extremely obese, with an average adult BMI of 43 kg/m² [4]. Though multidisciplinary behavioral programs have resulted in modest and sustained decreases in BMI and health risks in less severely obese children, behavioral or dietary interventions have not resulted in significant or sustained improvements in BMI for *extremely* obese children and adolescents [5,6].

Over the past decade, bariatric surgery has gained increasing acceptance as a treatment modality for adolescents with extreme obesity and significant comorbid diseases who have failed conventional dietary or behavioral interventions. This review will summarize the indications for, and outcome of bariatric surgery in adolescents and highlight the physiologic changes occurring post-operatively that may contribute to decreases in appetite and food intake, leading to durable reduction in weight.

2. Overview of bariatric surgery in adolescents

Bariatric surgery has been performed in adolescents since the 1970s and 1980s [7]. From 1996 to 2000 the annual rate of bariatric surgery in adolescents remained constant with approximately 200 cases per year [8]. However, from 2000 to 2003, the annual volume of cases increased threefold, reflecting a growing recognition of both the increasing prevalence and severity of adolescent extreme obesity and acceptance of bariatric surgery as a safe and effective weight loss tool for selected extremely obese adolescents.

2.1. Indications

Indications and contraindications for considering bariatric surgery in adolescence have been extensively reviewed elsewhere [7,9]. Briefly, because of the unique psychosocial, physical, behavioral and emotional needs of adolescents and their families, adolescent bariatric surgery should take place within the context of a pediatric multidisciplinary center and more conservative patient selection criteria are advocated. Typically, bariatric surgery has been recommended only for

adolescents with a BMI ≥ 40 kg/m² with a major comorbidity (diabetes, obstructive, pseudotumor cerebri) or BMI ≥ 50 kg/m² with or without major comorbidities [10]. Prior attempts at weight loss through behavior or dietary changes must be well documented. Multidisciplinary evaluation by pediatric specialists is advised to ensure that the patient and family understand the risks and benefits and meet selection criteria [11]. Guidelines based on strict BMI cut-point of 40 or 50 kg/m² may however eventually be replaced by BMI guidelines based on the 99th percentile for BMI, as this may be a more precise cut-point to identify extremely obese teens with high likelihood of having significant cardiovascular and dysmetabolic risk factors, as well as persistence of extreme obesity into adulthood [4,12].

2.2. Surgical options for adolescents

Historically, both the jejunoileal bypass (JIB) (Fig. 1a) and the biliopancreatic diversion (BPD) (Fig. 1b) were performed in adolescents in the 1970s and 1980s [13,14]. Both have since been abandoned, due to the large malabsorptive component of these procedures and high risk of nutritional complications, morbidity and mortality that resulted from bypassing the majority of the small intestine [14–16]. The modified biliopancreatic diversion with duodenal switch (BPD-DS) (Fig. 1c) which preserves a cuff of duodenum and lengthens the common small intestinal channel, has also been performed in a small number of adolescents [17]. However, the BPD-DS also carries an increased risk of malabsorptive complications and requires life-long nutritional supplementation. It is therefore only rarely performed, typically in adolescents at the highest extremes of BMI. A small number of adolescents also received vertical banded gastroplasty (VBG) (Fig. 1d) in the 1980–1990s [18]. However, due to modest weight loss and higher risk of post-surgical complications, this procedure is also no longer performed in adolescents.

The two main surgical options for adolescents at present include the Roux-en-Y gastric bypass (RYGB) and the laparoscopic adjustable gastric banding (LAGB). The RYGB remains the most commonly performed procedure, comprising 90% of adolescent bariatric surgery cases in the United States in 2003 [8]. However, the first stage of the BPD-DS, the vertical sleeve gastrectomy (VSG) is gaining increasing interest due to a predictably lower risk of nutritional complications and weight loss performance that is potentially comparable to other procedures (discussed below) [17].

RYGB (Fig. 1e) has been used for surgical weight loss in adolescents since the 1980s and remains the most common bariatric procedure performed in obese adolescents [8,19,20]. Technically, a small 20–30 ml gastric pouch is fashioned just below the gastroesophageal junction. This excludes the fundus and body of the stomach, which may have important physiologic considerations, as discussed in Section 3. The roux limb is typically 75–150 cm in length and is anastomosed to the gastric pouch. The surgery therefore includes

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