










Review

Metabolic surgery in severely obese adolescents: which technique provides the best benefits?

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ARTICLE INFO

Article history:

Received 25 June 2024

Received in revised form 01

September 2024

Accepted 21 September 2024

Keywords:

Obesity

Pediatrics

Morbid obesity

Bariatric surgery

ABSTRACT

Obesity is a public health and global health problem due to the disease burden it generates across all age groups, as well as being a pandemic due to its high prevalence worldwide. Bariatric surgery has traditionally been described as an aggressive option in the adolescent population. However, as the evolution of these patients over time and the improvement in health outcomes have been rigorously analyzed, it is positioned as an effective and safe intervention. Recently, novel high-quality evidence has emerged, sparking international scientific discourse on which techniques provide the most benefits and are safer in bariatric surgery for adolescents with severe obesity. Then, the aim of this review was to analyze the most recent clinical evidence, based on study designs, regarding clinical and surgical outcomes obtained by surgical techniques used during bariatric surgery in the management of severe obesity in adolescents. After the literature review, it was identified that surgical resolution for severe obesity in adolescents is effective and safe, with better benefits observed when using Roux-en-Y gastric bypass. There is a similar frequency of adverse events compared to sleeve gastrectomy and gastric banding. Micronutrient deficiency is the primary adverse event, which is potentially preventable and treatable.

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<https://doi.org/10.53986/ibjm.2024.0023>

Cirugía metabólica en adolescents con obesidad severa: ¿Qué técnica provee mejores beneficios?

INFO. ARTÍCULO

Historia del artículo:

Recibido 25 Junio 2024

Recibido en forma revisada 01

Septiembre 2024

Aceptado 21 Septiembre 2024

Palabras clave:

Obesidad

Pediatría

Obesidad mórbida

Cirugía bariátrica

RESUMEN

La obesidad es un problema de salud pública y global debido a la carga de enfermedad que genera en todos los grupos de edad, además de ser una pandemia por su alta prevalencia a nivel mundial. La cirugía bariátrica ha sido tradicionalmente considerada como una opción agresiva en la población adolescente. Sin embargo, a medida que la evolución de estos pacientes a lo largo del tiempo y la mejora en los resultados de salud han sido rigurosamente analizados, se posiciona como una intervención eficaz y segura. Recientemente, han surgido pruebas novedosas de alta calidad, generando un discurso científico internacional sobre qué técnicas proporcionan mayores beneficios y son más seguras en la cirugía bariátrica para adolescentes con obesidad severa. Por lo tanto, el objetivo de esta revisión fue analizar las evidencias clínicas más recientes, basadas en diseños de estudio, en relación con los resultados clínicos y quirúrgicos obtenidos por las técnicas quirúrgicas utilizadas durante la cirugía bariátrica en el manejo de la obesidad severa en adolescentes. Después de la revisión de la literatura, se identificó que la resolución quirúrgica para la obesidad severa en adolescentes es efectiva y segura, con mejores beneficios observados al utilizar el bypass gástrico en Y de Roux. Existe una frecuencia similar de eventos adversos en comparación con la gastrectomía en manga y la banda gástrica. La deficiencia de micronutrientes es el principal evento adverso, el cual es potencialmente prevenible y tratable.

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HOW TO CITE THIS ARTICLE: Osorno Avendaño D, Paez Silva MC, Londoño Fonseca AM, Vergara Torrente JA, Rodríguez Ocampo C, Ruiz-Gutierrez FK, Picón Y. Metabolic surgery in severely obese adolescents: which technique provides the best benefits? Iberoam J Med. 2024;6(4):114-119. doi: 10.53986/ibjm.2024.0023.

1. INTRODUCTION

Obesity is a public health and global health problem due to the disease burden it generates across all age groups, as well as being a pandemic due to its high prevalence worldwide [1]. Specifically, childhood obesity has become a priority challenge due to the dramatic increase in its prevalence, with more than 340 million cases reported among those aged 5–19 years [2, 3]. Considering that this is a preventable condition significantly associated with a large number of both chronic and acute complications in numerous organs, in the short-, medium-, and long-term, diverse international guidelines and consensus recommend its complete resolution to improve the quality of life and healthy lifespan of children and adolescents, as well as their upcoming years [3, 4].

Bariatric surgery has traditionally been described as an aggressive option in the adolescent population [4]. However, as the evolution of these patients over time and the improvement in health outcomes have been rigorously analyzed, it is positioned as an effective and safe intervention [5-7]. Nevertheless, it has more frequently been used only in cases of severe obesity [6]. To date, the benefit-

risk balance is known, compared to pharmacological interventions and lifestyle modification, with bariatric surgery described as the most effective in weight loss, reduction of metabolic syndrome prevalence, improved aesthetics, self-satisfaction, and quality of life [4-8]. However, some surgical techniques differ in terms of risk and benefits, requiring the customization of each case, while maintaining the precision of the evidence [5, 8]. Recently, novel high-quality evidence has emerged, sparking international scientific discourse on which techniques provide the most benefits and are safer in bariatric surgery for adolescents with severe obesity [9]. Recognizing the relevance and global impact of knowing the interventions with the best performance in resolving severe obesity in adolescents, the aim of this review was to analyze the most recent clinical evidence, based on study designs, regarding clinical and surgical outcomes obtained by surgical techniques used during bariatric surgery in the management of severe obesity in adolescents.

2. METHODS

A bibliographic search was carried out using search terms such as "Bariatric Surgery", "Adolescents" and "Obesity", as well as synonyms, which were combined with the Boolean operators "AND" and "OR", in the databases PubMed, ScienceDirect, Embase, EBSCO, and MEDLINE. As inclusion criteria, it was determined that any clinical study focused on outcomes related to bariatric/metabolic surgery for severe obesity in adolescents would be included. In addition, they had to be available in full text. As non-inclusion criteria, it was established that articles published in a language other than Spanish and English would not be included. Articles published until 2024 were included. A total of 34 potentially relevant articles were identified, with a review of the title and abstract of all of them, of which 14 articles were finally included. Additional references were included. The estimates and calculations found were expressed in their original measures, whether frequencies, percentages, confidence intervals (CI), mean difference (MD), relative risk (RR), odds ratio (OR) or hazard ratio (HR).

3. CLINICAL EVIDENCE COMPARING SURGICAL TECHNIQUES USED IN METABOLIC SURGERY FOR TREATMENT OF SEVERE OBESITY IN ADOLESCENTS

3.1. OBSERVATIONAL STUDIES

As of the present date, observational studies addressing issues related to bariatric surgery and severe obesity in adolescents share a particular characteristic; a significant portion of these studies originate from European countries or the United States.

Over 10 years ago, in 2012, Olbers et al [10] conducted the AMOS study in Sweden with the aim of evaluating outcomes at two years obtained during the surgical management of severe obesity in adolescents. They compared laparoscopic Roux-en-Y gastric bypass to conservative management. 162 adolescents (81 subjects in both groups) were included, with a body mass index (BMI) range of 36–69 kg/m². The researchers found that in the intervention group, there was a reduction in BMI of just over 15 kg/m² ($p < 0.001$), corresponding to 32% at two years, compared to the control group, where there was a 3% weight gain. In the intervention group, 70% of cases showed hyperinsulinemia, which reduced to 3% at 24 months. Tolerance and quality of life were additional favorable outcomes in the intervention group [10]. In 2016, Inge et al

[11] conducted a similar follow-up but extended it to three years, comparing Roux-en-Y gastric bypass (161 subjects) with sleeve gastrectomy (67 subjects). The authors reported no differences in weight reduction between the two techniques (28% with gastric bypass vs. 26% with sleeve gastrectomy). Both techniques showed significant remission at three years in metabolic conditions such as prediabetes, dyslipidemia, hypertension, and renal function impairment. However, this trend was more pronounced with the use of gastric bypass. The only complication observed over time was micronutrient deficiency and hypoferritinemia [11].

Three other studies [12-14], conducted in subsequent years, included 91 to 161 adolescents with morbid obesity undergoing bariatric surgery, with a follow-up of five years. They determined that both sleeve gastrectomy and gastric bypass resulted in sustained excess weight loss, total weight loss, and sustained BMI loss over time, up to 49%, 23%, and 23%, respectively. In the studies by Inge et al [13] and Khidir et al [14], comparing outcomes over time with an adult population, it was evident that adolescents had a higher remission of type 2 diabetes mellitus and arterial hypertension and expressed greater satisfaction with body aesthetics. However, adolescents tended to suffer more frequently from hypoferritinemia, micronutrient deficiency, compared to adults, as well as a need for abdominal reoperation [12-14]. A 19-year follow-up from a single center in the United States of 167 adolescent and young patients undergoing bariatric surgery [15] demonstrated that gastric bypass leads to greater weight loss over time (-36% BMI; $p < 0.001$), compared to sleeve gastrectomy (-25% BMI) and gastric banding (-14% BMI). Gastric bypass is the technique that most consistently maintains the status of sustained and gradual weight loss over 15 years compared to the other two. However, gastric banding (41%) is the technique with the highest reoperation requirement, compared to bypass (24%) and sleeve gastrectomy (5.4%) [15].

Howard et al [9], who analyzed the use of medical resources and adverse events in adolescents with morbid obesity undergoing metabolic surgery (855 cases of gastric bypass vs. 277 cases of sleeve gastrectomy) up to five years later in the USA, found that sleeve gastrectomy was significantly associated with a lower need for emergency visits (53.3% vs. 59.9%) and hospitalization (36.9% vs. 52.1%), but not with complications (1.5% vs. 2.1%) and the need for reoperation (7.2% vs. 7.7%) compared to bypass. There were no differences in terms of deaths [9]. Thus, up to this point, observational studies show that although preventable adverse events are similar between techniques with supplementation, gastric bypass provides better sustained

benefits over time regarding sustained weight loss and remission of metabolic pathological conditions

3.2. CLINICAL TRIALS

In 2014, the results of the Teen-LABS study [16] were published, evaluating the postoperative safety of 277 adolescents with severe obesity, polymorbidities, and undergoing metabolic surgery. The researchers found that there was a higher frequency of major and minor complications in the gastric bypass group at 30 days, compared to sleeve gastrectomy and gastric banding; however, this difference was not statistically significant. There were no deaths. The Roux-en-Y gastric bypass was the most used technique (66.5%), followed by sleeve gastrectomy (27.7%) [16]. In 2017, the results of the Swedish AMOS study were published [17], where 100 adolescents with severe obesity underwent bariatric surgery. It was demonstrated that, at five years, the average weight loss for adolescents was approximately 37 kilograms, and weight regain was similar in both adolescents and adults. Compared to adolescents in the control group (not undergoing surgical intervention), the intervention group showed a more notable improvement in risk factors and metabolic conditions. However, 25% of the operated cases required reintervention, and 72% presented micronutrient deficiency [17].

The AMOS2 study [18], which evaluated BMI changes and safety and health outcomes after bariatric surgery in 25 adolescents with severe obesity, compared to a control group (25 adolescents with non-surgical treatment). At two years, it was observed that cases undergoing surgical intervention had an average BMI reduction of 12.6 kg/m², compared to 0.2 kg/m² in the control group. Only four adverse events were reported after surgery, although this same group showed a greater reduction in bone mineral density. There were no differences in terms of micronutrient

status, gastrointestinal symptoms, or mental health at two years [18].

Thus, through these trials, it is evident that metabolic surgery provides better results in terms of weight reduction and remission of metabolic diseases in adolescents with severe obesity, primarily at 24 months, compared to control groups. There seem to be no significant differences in the occurrence of adverse events, with no reported deaths, and in cases of micronutrient deficiency, this condition is preventable and correctable.

3.3. SYSTEMATIC REVIEWS

Four systematic reviews evaluated this problem until date. Qi et al [19] in late 2017 systematically analyzed 49 studies with 3007 cases of adolescents with morbid obesity undergoing bariatric surgery, aiming to understand the effect of this intervention on metabolic parameters, surgical complications, and quality of life. The techniques used were Roux-en-Y gastric bypass, sleeve gastrectomy, and gastric banding. A general reduction of 31% in BMI was found over a time range of 12 to 120 months of follow-up. At 12 months, there was a significant reduction in glycosylated hemoglobin, serum glucose, total cholesterol, triglycerides, high-density lipoproteins (HDL), and low-density lipoproteins (LDL). Remission of dyslipidemia was 70% at 3 years and 95% at 5 years. It was identified that gastric bypass provided the best benefits [19].

Shoar et al [20] analyzed the long-term outcomes of 14 studies with 950 cases with a minimum follow-up of 3 years, showing that gastric bypass and gastric banding were the most commonly performed interventions. On average, a BMI loss of 13.3 kg/m² was found, and type 2 diabetes mellitus achieved the highest remission. Weight regain < 5 kg/m² was identified at six years of follow-up. Only three deaths were reported [20]. In 2023, Wu et al [21] evaluated the same previous outcomes but with a minimum follow-up

Table 1: Effects of the different techniques in the post-intervention period

Technique	Postoperative Effects	Follow-up Duration	Complications	Reference
Gastric Bypass	Rapid weight loss, higher risk of malnutrition, complications like leaks	12 - 24 months	Micronutrient deficiencies, dumping syndrome, and postoperative complications (bleeding, intestinal obstructions).	[29]
Sleeve Gastrectomy	Moderate weight loss, fewer complications, vitamin deficiencies	12 months	Lower complication rates than gastric bypass, but there is a risk of leakage and nutritional deficiencies.	[30]
Adjustable Gastric Banding	Slower weight loss, fewer nutritional issues, high risk of reoperation	24 months	Low risk of perioperative complications (0.8% bleeding, 1.4% infection), but 14.7% required reoperation for band-related complications (e.g., dislodgement).	[29]

of five years, including 29 cohort studies with a total of 4970 adolescents. After five years, the average BMI loss was approximately 13 kg/m². This time, sleeve gastrectomy resulted in an average reduction of 15.2 kg/m², while gastric bypass caused an average reduction of 12.8 kg/m². Remission of diseases such as type 2 diabetes mellitus, dyslipidemia, arterial hypertension, and asthma was 90%, 76.6%, 80.7%, and 92.5%, respectively. No postoperative complications were reported, and there were only a few cases of iron and cobalamin deficiency [21].

undergo this intervention (Table 2). It is expected that the probability of maintaining weight loss and related benefits will persist over time [23-25].

Based on these benefits, it would be useful to reassess inclusion criteria and decision-making in adolescents, who would experience a significant reduction in cardiometabolic risk factors and non-communicable chronic diseases from an early age. Considering essential clinical and methodological aspects, decisions regarding clinical interventions to address morbid obesity in adolescents must be made following the

Table 2: Criteria for metabolic surgery techniques in severely obese adolescents

Technique	Clinical criteria	Reference
Gastric Bypass	- BMI ≥ 40 kg/m ² with severe comorbidities (type 2 diabetes, obstructive sleep apnea, etc.). - Failure of non-surgical interventions.	[31, 32]
Sleeve Gastrectomy	- BMI ≥ 35 kg/m ² with comorbidities or BMI ≥ 40 kg/m ² without comorbidities. - Preferred in young patients due to its lower complexity.	[31, 32]
Adjustable Gastric Banding	- BMI ≥ 35-40 kg/m ² with mild comorbidities. - Preferred for adolescents due to its reversibility.	[31, 32]

Finally, the most recent meta-analysis to date was conducted by Al-Mohaidly et al [22], where they evaluated outcomes of sleeve gastrectomy in adolescents and young people with severe obesity. The authors included 37 studies with a total of 2300 patients. The researchers determined that the average BMI loss was approximately 18 kg/m². Gastroesophageal reflux was the most common complication. However, similar to previous meta-analyses, a significantly high remission of metabolic diseases such as type 2 diabetes mellitus, arterial hypertension, and obstructive sleep apnea was observed [22].

Then, the qualitative and quantitative synthesis of the evidence on this topic, without explicit data on methodological quality, reporting, and risk of bias, suggests that the efficacy of all described techniques in terms of long-term weight loss (minimum 2 years) and remission of metabolic diseases is evident. It is also crucial to consider micronutrient deficiency as a potential complication in the medium and long term. However, gastric bypass provides greater intensity of these benefits, with a similar frequency of reintervention to other techniques, which is very low.

highest standards of clinical evidence. For this reason, there is increasing global interest in having various working groups explore the benefits and specificities of such interventions, while constantly updating clinical definition criteria [26]. These conditions have shown a significant impact on life expectancy and healthy life expectancy [27], especially in low- and middle-income countries where there has been a dramatic increase in the prevalence of obesity and severe obesity without effective health strategies. Additionally, a significant avenue of work would involve meta-investigative analysis of these interventions to have explicit data on the quality of published evidence [28].

4. FUTURE PERSPECTIVES

During the approach to bariatric surgery, there are more long-term benefits than just weight loss (Table 1). The remission of metabolic syndrome, encompassing metabolic entities and risk factors [23], as well as the promotion of outcomes related to mental health, aesthetics, and satisfaction [23,24], are relevant aspects for the decision to

5. CONCLUSIONS

The evidence suggests that the surgical resolution for severe obesity in adolescents is effective and safe, with better benefits observed when using Roux-en-Y gastric bypass. There is a similar frequency of adverse events compared to sleeve gastrectomy and gastric banding. Micronutrient deficiency is the primary adverse event, which is potentially preventable and treatable.

6. CONFLICT OF INTERESTS

The authors have no conflict of interest to declare. The authors declared that this study has received no financial support.

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