Bariatric Surgery in Adolescent Age Group

Dr. Haider Ali ALRamahi

Associate professor in general surgery, Consultant in general laparoscopic surgeon Bariatric and metabolic surgery, Osol AL-Elm University
Gmail: haiderali63@yahoo.com

KEYWORDS
adolescent, Bariatric surgery, pediatric.

ABSTRACT
Obesity in children is a problematic condition which interfere with physical and mental health. It is a complicated disorder with interwoven environmental, genetic, biological components, developmental, and behavioral. A combination of medical treatment and behavioral and lifestyle modifications was typically what causes poor short-term weight loss and long-term failure. For this reason, adolescents who suffer from moderate to severe obesity and have attempted lifestyle interventions in the past but had no success should think about having bariatric surgery. Specifically, laparoscopic sleeve gastrectomy is thought to be the most often carried out bariatric procedure globally. The technique is safe and doable. It has been demonstrated that this surgical weight loss procedure is effective in young patients. However, there are obstacles that need to be removed at the levels of patients, providers, and the healthcare system. Above all, for ensuring successful long-term treatment and permit healthy growth, more should be done to stop the nutritional status decline that frequently follows bariatric surgery, as well as to prevent insufficient weight loss and weight regain. With a focus on LSG, nutritional management, and the resolution of metabolic comorbidities, we examined the clinical indications, surgical treatment options, and outcomes in adolescents with severe obesity in this narrative review.

1. Introduction

Adolescents and children aged from 5 to 19 years experienced obesity and overweight in duration from 2017 to 2022 for about 230 case of obesity .85 case of them response to medical treatment and change in life style and only 55 case under want sleeve gastrectomy and about 90 case under want allurion balloon implant. This data for bariatric specially clinic and in private center and hospital for about 5 years of fellow up most of patient.

The classification of case we depend on BMI basification and growth chart for small age group.

From those patients 55 the BMI refer to obesity type three above 40%.

And all of them underwent diet program and use some medication and change in life style for about 6month duration but without benefit.

So 55 case under want sleeve gastrectomy scoring to standard procedure of IFSO (1). Demonstrate the incidence of obeity as high values: 14.2% of young peoples from 8 to 19 are categorized as overweight,18.7% with obesity and 9.1% with class III obesity (severe obesity) [2]. Obesity in pediatric associated with multifactorial disease that affect on morbidity and mortality even in social behaviore. [2,3], the situion of pediatric patient defernet from the adult duo to different factor from age and biological and enviroment factor also genetic factors .

The obesity in pediatric associate with may disorder for example Type 2 Diabetes mellitus [4], Dyslipidemia disease [5], (NAFLD) [6], (OSA) [7], and (PCOS) [8], and adolescents with obesity are at elevated hazard of many psychological disruption

In the majority of situations, treating severe obesity over the long term with diet, lifestyle changes, and currently prescribed medications is comparatively ineffective [9]. With more surgeries being performed in Europe [11], the US [12], and other countries [13], bariatric surgery has thus emerged as a therapeutic approach for teenagers [10].

Particularly, it has been acknowledged that laparoscopic sleeve gastrectomy (LSG) is a legitimate bariatric surgery technique in and of itself. Patients under the age of 18 can safely and effectively undergo this surgical treatment, which improves quality of life (QoL), results in comorbidity remission, and causes significant weight loss [13, 14]. The treatment of severely obese adolescents must include multidisciplinary interventions. Preoperative and postoperative nutritional optimization should receive particular consideration in order to maximize outcomes.

With a special emphasis on LSG, nutritional management, and the resolution of metabolic comorbidities, we examine the clinical indications, surgical treatment options, and outcomes in adolescents with severe obesity in this narrative review.

Most industrialized nations are impacted by the serious public health issue of childhood obesity [1]. To evaluate overweight or obesity in children and adolescents, there are currently three main classifications in use. WHO, IOTF, and CDC all base their cut-off values on growth curves. Depending on to WHO classification, when a child's BMI for age and gender is at or more the 85th percentile and under the 97th percentile or above the 97th percentile, respectively, [15. 16], it is considered overweight or obese.

The IOTF system application smooth gender-specific BMI curves, constructed to match the values of patient with 25 kg/m2 to 29kg/m2 (Overweight) and _30 kg/m2 (Obesity) even the obesity its divided into type 1 or obesity type 2 or obesity type 3 or malignant obesity (morbid obesity)depend on BMI.

In some country there are others factors that added to BMI classification for decision of treatment plane like social factors and sex or gender factors and even the level of education of family with environment and finaly the level of country its self as developing or developed country [17].

It's common knowledge that there are many diseases and complications linked to obesity, such as those pertaining to the metabolism and heart (see below).

Cardiovascular

Hypertension (elevation in blood pressure)

Dyslipidemia(elevation in lipid profile)

Endocrinology

Type II Diabetes Mellitus(elevation in blood sugar)

Precocious puberty(early puberty)

Insulin resistance(pre diabetic condition)

PCOS(poly cystic ovarian syndrome)

irregularities menstrual cycle

Gastrointestinal

GIRD (Gastroesophageal reflux disease)

Non-alcoholic fatty liver disease(fatty liver)

Gall bladder stones

Orthopedics

Flat feet

Tibia vara

Join pain

Arthritis

Blount’s disease

Ankle sprains

Slipped capital femoral epiphysis

Renal

Nephrotic Syndrome

Glomerulonephritis

Respiratory

Obstructive sleep apnea

Asthma

Dermatological

Acanthosis Nigricans

Striae

Abnormal hair distribution

Hidradenitis Suppurativa

Psychological

Sleep Disturbance

Eating disorder

Poor-self-Esteem

Depression

Poor Body Image

Anxiety

Neurological

Headache

Pseudotumor cerebri

Depression

2. Method and procedure

All investigation should be done for the patient include blood ample (urea ,creatine ,liver function test ,thyroid function test and, CBC)

Abdominal U/S and chest X-ray

And multidisplinary team work include consultation for dietation and endocrinologist and general physicion and pediatration and psychatration .

Even the family of the patient is very important part of treatment to help the patient to change the habit or life style .

Finaly the surgeon (barieatic surgeon) with anastithest should be discuse togather before start operation .

Prophylactic does of antibiotic at the time of induction and anticoagulant prophylactic does 5 hr after operation.

Pneumatic sockes or leg message its recommended for obese patient.

The laparoscopic approach for sleeve gastrectomy similar to adult only different in

Small and important point .

Check gastroscope is manditary before start operation

4 ports use ,sealing system bipolar used ,

Calliparation tune bougi Size 40F is better

And start dissection of grater omentum eom greter curvature .

Then ues tristeplear thin in thiknes from bout 2mm to 3.5 mm because the tomach in peitric very thin .

An start cutting the stomach 4 -6 cm from pyloric sphincter to gastroesophagel junction and keep angle of hiss 2 cm from gastroesophageal unction to prevent or decrease the refleax to the esophaguse .

Tast by methyle blue test or air bubble test to be sure no leak then check the hamostaisis and bleeding and putting the drain its depend on situation of operation .

Its necessary to treated and mangement the obesity in peadatric age group before reach to Adult to prevent the incidince of chronic disease and decrase incidance of complication rate to many systems of the body [26].

3. Result

Adolescents and childern

From 5to 19 years who suffering from overweight and obesity in duration from 2017 to 2023 for about 230 case of obesity .85 case of them response to medical treatment and change in life style and only 55 case under want sleeve gastrectomy and about 90 case underwant allurion balloon implant.

This data for bariatric specialiy clinic and in peivate center and hospital for about 5 years of fellow up most of patient .

The classification of case we depend on BMI casification and growth chart for small age group.

4. Discussion

It is evident that modifying a child's lifestyle, following a diet plan (see dietation), engaging in physical activity, and using medication are the first steps in treating obesity and metabolic syndrome.

alterations in conduct. Regardless of one's level of adiposity, the Endocrine Society Clinical Practice Guidelines suggest 20 minutes a day of moderate-to-vigorous physical activity to reduce body weight and enhance insulin sensitivity by addressing the insulin resistance that results from obesity [27–29].

Furthermore, it is highly advised to follow a balanced, high-fiber diet, as this has been linked to improved peripheral insulin sensitivity [30,31], a decreased hazard of childhood and teenage diabetes mellitus, a reduction in fasting blood glucose and systolic blood pressure [32], and a healthier composition and diversity of gut microbiome, that could have an impact on energy balance and nutrient metabolism [33]. On the other hand, numerous researches have demonstrated that eating a lot of fat reduces insulin sensitivity [34, 35], independent of how fat an adolescent is [36].

Furthermore, when a high intake of saturated fats is combined with an excessive intake of salt, simple sugars, refined grains, and fiber, as is the case with the Western diet [37, 38], this can lead to changes in the gut microbiome profile from a healthy pattern to one that is more prevalent in obesity [39, 40]. It can also promote inflammation [38]. The Western diet has an impact on the development of hypertension as well. For children and adolescents with hypertension, AAP recommends implementing the (DASH) diet, which is sweets, low in sugar, and sodium and high in fruits, vegetables, fish, whole grains, poultry, nuts, and lean red meat [41].

In addition to dietary and lifestyle changes, prescription drugs for weight loss may be prescribed if necessary. However, as of yet, no one medical strategy has been shown to be consistently or singularly effective for long-term use in the treatment of obesity in children or adolescents with severe weight problems. Medication for weight loss is costly, not covered by health insurance, and the majority of medications are still being investigated for their safety when used in children.[41]. Furthermore, 4–47% of patients taking medication for weight loss may experience negative side effects [42, 43]. But the most recent information available on the use of drugs to lose weight indicates promise in the field of pediatrics [44, 45].

There are extremely few pharmacological treatments for childhood obesity that have been approved. The FDA has approved phentermine, a sympathomimetic amine, for use in teenagers aged 16 and younger, liraglutide, an agonist of the glucagon-like peptide-1 receptor (GLP-1), for use in pediatric patients aged 7 to 11 years, and orlistat, also known as Xenical, which functions as an intestinal lipase inhibitor for adolescents aged 12. The European Medicines Agency (EMA) also approved the drug formaline this year for children aged 13 to 17 [46]. Formaline decreases the absorption of glucose.

The biguanide metformin is the first-choice drug and is widely prescribed by a physician or administered by hand by the patient's family. By suppressing hepatic gluconeogenesis and increasing intestinal absorption of glucose, it lowers blood glucose levels when taken orally [47–49].

Metformin lowers the risk of diabetes mellitus even though it rarely causes a noticeable reduction in body weight [50]. It emerge to block or delay changes in glucose homeostasis in children who are at high hazards of

developing type 2 diabetes mellitus.

Added to that its impossible or not recommended for use of medication for long time because of side effect of medication and some time the patient untolerance for chronic use of medication and finally he will be reach to point that he stope medication either duo to side effect or other social facters ; at this point weight regain is very rapidly and will cause psychological trauma to the patient .

Change in life style is very good for weight reduction ;continuous on physical activity is very important to maintain body weight but the physical activity or portage without change in diet program it will be not reduce the body weight .

On other side the use of intragastric balloon is effective method for weight loss and have good result if its join with diet program that recommend ad from dietitian and from medical balloon company (like allurion balloon)or orbera intragastric balloon .but unfortunately even with balloon the failure rate for weight reduction is high and weight regain after balloon removal is very high for that reason the surgical treatment in pediatic age group like sleeve gastrectomy its appear and start to get successful rate for weight loss is good and accepted in short and long duration .

Criteria for Bariatric Surgery in adolescent

Not more different from criteria in adult we depend mainly on BMI .

In pediatric patient we keep sticky to restrictive teachnique rather than malabsorbative teachniqe to avoid or decrease incidence of malnutrition and vitamin and minerals difficency .

The pediatric patient during growth rate of the life so try to avoid any difficency in minerals or viamine specialy vitamin D3 and calcium and iron .

The European Association for Endoscopic Surgery has criteria for use surgery in pediatric patient as the fellowing list

1- patients with BMI _ 40 kg/m2,

2- patients withBMI _ 35–40 kg/m2 with comorbidities

3- Patients with _ BMI 30–35 kg/m2 associated with type 2 diabetes or hypertension with poor control despite optimal medical

Treatment [69].

Time of bariatric operation in pediatric patient

After conclusion with BMI and dicienion for surgery so keep in your mind the fellowing points

1- Patient with at least six months chance of life style change for losing weight under close supervision.

2- Patient reach complete or near complet of skeletal and sexual maturation because some time imposible to reach to full skeletal maturation with obesity

3- patient have fuul information and totally under stand the details of diet program post operatively and should have full information about the procedure (major point) with sufficient understanding of the procedure and complication of its

4-comprehensive psychological and medical evaluation before and after surgery by psychiatrist so multidisplinary team is manditary .

There are some contraindication for bariatric surgery in adolescent age group

1. 1 _ Obesity that can be treated by medical therapy.
2. BMI Less than 30%
3. Planne for pregnancy within 12–18 months of the scheduled surgical procedure.
4. Concomitant eating disorders patient out of controle .
5. Medical or psychiatric or psychosocial issues that interference with postsurgical recommendations

6. Patient unfit for general anesthesia

5. Recommendation

Laparoscopic Sleeve Gastrectomy as Preferred Surgical Approach as I mension perviosly becouuse it restrictive procedure not affect on malabsorbative teachnique .

Another bariearic procedure like R- en- Y gastric bypass and minigastric bypass or single anastomosis gastric bypass and SASI procedure and adjustable gastric band all of this procedure can be use for weitht loss in adult but not prefer for pediatric age group only in special condision .

The recommendation for pediatric age group try to avoid malabsorbative procedure and don't rush the patient immediately for surgical intervension for weight loss but keep as multidisplinary team decision

Also don't hesitate in family duty for help the surgeon to get good result for weight loss and maintain weight loss also to avoid complication in early stage .

Some time its necessary to give chance for the patient for weight loss by intragastric balloon before decision for surgery.

References

[1] Wang G, Dietz W. Economic burden of obesity in youths aged 6 to 17. Pediatrics May 2002;109:81–9.

[2] Tsai WS, Inge TH, Burd RS. Bariatric surgery trends in adolescents. Arch Pediatr Adolesc Med 2007;161:217–21.

[3] Inge TH, Lawson L. 2004 ASBS consensus conference. Treatment considerations for severe adolescent obesity. Surg Obes Relat Dis 2005;1:133–9.

[4] Allen SR, Lawson L, Garcia V, et al. Attitudes of bariatric surgeons concerning adolescent bariatric surgery (ABS). Obes Surg 2005;15:1192–5.

[5] Apovian C, Baker C, Ludwig D, et al. Best practice guidelines in pediatric/adolescent weight loss surgery. Obes Res 2005;13(2):274–82.

[6] Baltasar A, Serra C, Pérez N et al. Laparoscopic sleeve gastrectomy. A multi-purpose bariatric operation. Obes Surg 2005;15: 1124–8.

[7] Leon KM, McDermott JW, Salcedo IM, et al. Obesity surgery in a 12 year-old—an Ecuatorian experience. Obes Surg 2007; 1:258–9.

[8] Inge TH, Krebs NC, Garcia V, et al. Bariatric surgery for the overweight adolescents: consensus and recommendations. Pediatrics 2004;114:217–23.

[9] Rodgers BM. American Pediatric Surgical Association. Bariatric surgery for adolescents: a review from the American Pediatric Association. Pediatrics 2004;113:255–6.

[10] Barnett SJ, Stanley C, Hanlon M, et al. Long-term follow-p and the role of surgery in adolescents with morbid obesity. Surg Obes Relat Dis 2005;1:394–8.

[11] Buchwald H. Consensus conference statement. Bariatric surgery for morbid obesity: health implications for patients, health professionals, and third party payers. Surg Obes Relat Dis 2005;1:371–81.

[12] Breaux CW. Obesity surgery in children. Obes Surg 5:279–84.

[13] Capella JF, Capella RF. Bariatric surgery in adolescence: is this the best age to operate? Obes Surg 2003;13:826–32.

[14] Wittgrove AC, Buchwald H, Sugerman H. American Society for Bariatric Surgery for the severely obese adolescents: further insight from the American Bariatric Society. Pediatrics 2004; 114:252–4.

[15] Cohen R, Pinheiro JS, Correa JL. Bariatric surgery in adolescents is safe and effective. Surg Obes Relat Dis 2006;2:289.

[16] Collins J, Mattar S, Qureschi F, et al. Initial outcomes of laparoscopic RYGBP in morbidly obese adolescents. Surg Obes Relat Dis 2007;3:147–52.

[17] Morton JM, Albanese CT. National in-patient outcomes for adolescent bariatric surgery. Surg Obes Relat Dis 2005;1:258.

[18] Varela E, Hinojosa M, Nguyen N. Bariatric surgery in adolescents: analysis of 309 cases. Surg Obes Relat Dis 2007;3:277.

[19] Chandra V, Dutta S, Albanese C, et al. Clinical resolution of severe symptomatic pseudotumor cerebri after gastric bypass in an adolescent. Surg Obes Relat Dis 2007;3:198–200.

[20] Courcoullas A, Eagleton J, Udekwu AO, et al. Bariatric surgery in adolescents: an historical case series. Surg Obes Relat Dis 2005;1:299.

[21] Silberhumer GR, Miller K, Krivanek S, et al. Laparoscopic adjustable gastric banding in adolescents: the Austrian experience. Obes Surg 2006;16:1062–7.

[22] Fielding GA, Duncombe JE. Laparoscopic adjustable gastric banding in severe obese adolescents. Surg Obes Relat Dis 2005;1: 399–407.

[23] Aninoach E, Lansberg L, Mizrahi S. Gastric banding for the morbidly obese adolescents. Surg Obes Relat Dis 2006; 2:310.

[24] Papadia FS, Adami GF, Marinari, et al. Bariatric surgery in adolescent: a long-term follow-up study. Surg Obes Relat Dis 2007;3:465–8.

[25] Pachand V, DaVee R, Alverdy J. Duodenal switch provides superior weight loss in super-obese (BMI>50 kg/m2) compared with gastric bypass. Ann Surg 2006;244:611–9.

[26] Strain GW, Gagner M, Inabnet WB, et al. Comparison of effects of gastric bypass and biliopancreatic diversion with duodenal switch on weight loss and body composition 1–2 years after surgery. Surg Obes Relat Dis 2007;3:31–6.

[27] Milone L, Strong V, Gagner M. Laparoscopic sleeve gastrectomy is superior to endoscopic intragastric balloon as a first stage procedure for the super-obese patient (BMI>50). Obes Surg 2005;15:612–7.

[28] Himpens J, Dapri G, Cadiere GB. A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: results after 1 and 3 years. Obes Surg 2006;16:1450–6.

[29] Langer FB, Reza MA, Bohdjalian A, et al. Sleeve gastrectomy and gastric banding: effects on plasma ghrelin levels. Obes Surg 15;1024–9.

[30] Fruhbeck G, Diez-Caballero A, Gil MJ, et al. The decrease in plasma Ghrelin concentrations following bariatric surgery depends on the functional integrity of the fundus. Obes Surg 2004;14: 606–12.

[31] Serra C, Baltasar A, Andreo L, et al. Treatment of gastric leaks with coated self-expanding stents after sleeve gastrectomy. Obes Surg 17;866–72.

[32] Baltasar A, Bou R, Bengochea M, et al. Use of a Roux limb to correct esophagogastric junction fistulas after sleeve gastrectomy. Obes Surg 2007;17:1408–10.

[33] Baltasar A, Serra C, Pérez N, et al. Re-sleeve gastrectomy. Obese

[34] Sloth B, Holst JJ, Flint A, Gregersen NT, Astrup A. Effects of PYY1–36 and PYY3–36 on appetite, energy intake, energy expenditure, glucose and fat metabolism in obese and lean subjects. Am J Physiol Endocrinol Metab. 2007;292:E1062–E1068. doi: 10.1152/ajpendo.00450.2006. [PubMed] [CrossRef] [Google Scholar]

[35] Russell-Jones D, Gough S. Recent advances in incretin-based therapies. Clin Endocrinol. 2012;77:489–499. doi: 10.1111/j.1365-2265.2012.04483.x. [PubMed] [CrossRef] [Google Scholar]

[36] Seeley RJ, Chambers AP, Sandoval DA. The role of gut adaptation in the potent effects of multiple bariatric surgeries on obesity and diabetes. Cell Metab. 2015;21(3):369–378. doi: 10.1016/j.cmet.2015.01.001. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[37] Chang SH, Stoll CR, Song J, Varela JE, Eagon CJ, Colditz GA. The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003–2012. JAMA Surg. 2014;149(3):275–287. doi: 10.1001/jamasurg.2013.3654. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[38] Olbers T, Gronowitz E, Werling M, Mårlid S, Flodmark CE, Peltonen M, Göthberg G, Karlsson J, Ekbom K, Sjöström LV, Dahlgren J, Lönroth H, Friberg P, Marcus C. Two-year outcome of laparoscopic Roux-en-Y gastric bypass in adolescents with severe obesity: results from a Swedish Nationwide Study (AMOS) Int J Obes. 2012;36(11):1388–1395. doi: 10.1038/ijo.2012.160. [PubMed] [CrossRef] [Google Scholar]

[39] Inge TH, Courcoulas AP, Jenkins TM, Michalsky MP, Helmrath MA, Brandt ML, Harmon CM, Zeller MH, Chen MK, Xanthakos SA, Horlick M, Buncher CR, Teen-LABS Consortium Weight loss and health status 3 years after bariatric surgery in adolescents. N Engl J Med. 2015;374(2):113–123. doi: 10.1056/NEJMoa1506699. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[40] Beamish AJ, Michalsky MP. Cardiovascular outcomes following adolescent bariatric surgery. Semin Pediatr Surg. 2020;29(1):150882. doi: 10.1016/k.sempedsurg.2020.150882. [PubMed] [CrossRef] [Google Scholar]

[41] Coulman KD, Hopkins J, Brookes ST, Chalmers K, Main B, Owen-Smith A, et al. A core outcome set for the benefits and adverse events of bariatric and metabolic surgery: the BARIACT project. PLoS Med. 2016;13(11):e1002187. doi: 10.1371/journal.pmed.1002187. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[42] Gunnel DJ, Frankel SJ, Nanchahal K, Peters TJ, Davey SG. Childhood obesity and adult cardiovascular mortality: a 57-y follow-up study based on the Boyd Orr cohort. Am J Clin Nutr. 1998;67(6):1111–1118. doi: 10.1093/ajcn/67.6.1111. [PubMed] [CrossRef] [Google Scholar]

[43] Michalsky MP, Inge TH, Simmons M, Jenkins TM, Buncher R, Helmrath M, Brandt ML, Harmon CM, Courcoulas A, Chen M, Horlick M, Daniels SR, Urbina EM, Teen-LABS Consortium Cardiovascular risk factors in severely obese adolescents: the Teen Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study. JAMA Pediatr.

2015;169(5):438–444. doi: 10.1001/jamapediatrics.2014.3690. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[44] Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, Schoelles K. Bariatric surgery: a systematic review and meta-analysis. JAMA. 2004;292(14):1724–1737. doi: 10.1001/jama.292.14.1724. [PubMed] [CrossRef] [Google Scholar]

[45] Michalsky M, Teich S, Rana A, Teeple E, Cook S, Schuster D. Surgical risks and lessons learned: mortality following gastric bypass in a severely obese adolescent. J Pediatr Surg Case Rep. 2013;1:321–324. doi: 10.1016/j.epsc.2013.08.013. [CrossRef] [Google Scholar]

[46] Beamish AJ, Johansson SE, Olbers T. Bariatric surgery in adolescents: what do we know so far? Scand J Surg. 2015;104(1):24–32. doi: 10.1177/1457496914553150. [PubMed] [CrossRef] [Google Scholar]

[47] Beamish AJ, Reinehr T. Should bariatric surgery be performed in adolescents? Eur J Endocrinol. 2017;176(4):D1–D15. doi: 10.1530/EJE-16-0906. [PubMed] [CrossRef] [Google Scholar]

[48] Magouliotis DE, Tasiopoulou VS, Svokos AA, Svokos KA, Chatedaki C, Sioka E, Zacharoulis D. Ursodeoxycholic acid in the prevention of gallstone formation after bariatric surgery: an updated systematic review and meta-analysis. Obes Surg. 2017;27(11):3021–3030. doi: 10.1007/s11695-017-2924-y. [PubMed] [CrossRef] [Google Scholar]

[49] Stenberg E, Szabo E, Ågren G, Ottosson J, Marsk R, Lönroth H, Boman L, Magnuson A, Thorell A, Näslund I. Closure of mesenteric defects in laparoscopic gastric bypass: a multicentre, randomised, parallel, open-label trial. Lancet. 2016;387(10026):1397–1404. doi: 10.1016/S0140-6736(15)01126-5. [PubMed] [CrossRef] [Google Scholar]

[50] Henfridsson P, Laurenius A, Wallengren O, Beamish AJ, Dahlgren J, Flodmark CE, Marcus C, Olbers T, Gronowitz E, Ellegard L. Micronutrient intake and biochemistry in adolescents adherent or nonadherent to supplements 5 years after Roux-en-Y gastric bypass surgery. Surg Obes Relat Dis. 2019;15(9):1494–1502. doi: 10.1016/j.soard.2019.06.012. [PubMed] [CrossRef] [Google Scholar]

[51] Beamish AJ, Gronowitz E, Olbers T, Flodmark CE, Marcus C, Dahlgren J. Body composition and bone health in adolescents after Roux-en-Y gastric bypass for severe obesity. Pediatric Obes. 2017;12(3):239–246. doi: 10.1111/ijpo.12134. [PubMed] [CrossRef] [Google Scholar]

[52] Ahlin S, Peltonen M, Sjöholm K, Anveden Å, Jacobson P, Andersson-Assarsson JC, et al. Fracture risk after three bariatric surgery procedures in Swedish obese subjects: up to 26 years follow-up of a controlled intervention study. J Intern Med. 2020;287(5):546–557. doi: 10.1111/joim.13020. [PubMed] [CrossRef] [Google Scholar]

[53] Dewberry LC, Khoury JC, Ehrlich S, Jenkins TM, Beamish AJ, Kalkwarf HJ, Xanthakos SA, Inge T. Change in gastrointestinal symptoms over the first 5 years after bariatric surgery in a multicenter cohort of adolescents. J Pediatr Surg. 2019;54(6):1220–1225. doi: 10.1016/j.jpedsurg.2019.02.032. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[54] Beamish AJ, D'Alessio DA, Inge TH. Controversial issues: when the drugs don't work, can surgery provide a different outcome for diabetic adolescents? Surg Obes Relat Dis. 2015;11(4):946–948. doi: 10.1016/j.soard.2015.03.006. [PubMed] [CrossRef] [Google Scholar]

[55] Shah AS, Nadeau KJ, Helmrath MA, Inge TH, Xanthakos SA, Kelsey MM. Metabolic outcomes of surgery in youth with type 2 diabetes. Semin Pediatr Surg. 2020;29:150893. doi: 10.1016/j.sempedsurg.2020.150893. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[56] Beamish AJ, Olbers T. Metabolic and bariatric surgery in adolescents. Nat Rev Gastroenterol Hepatol. 2019;16(10):585–587. doi: 10.1038/s41575-019-0187-x. [PubMed] [CrossRef] [Google Scholar]