

Surgical Procedures of Morbid Obesity

Zinat Salem, *¹ Mahmood Sheikh-Fathollahi²

1. Department of Social Medicine, Faculty of Medicine, Occupational and Environmental Health Center, Rafsanjan University of Medical Sciences, Rafsanjan, Iran
2. Department of Social Medicine, Faculty of Medicine, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

Article information	Abstract
<p>Article history: Received: 9 Feb 2012 Accepted: 15 Feb 2012 Available online: 28 Oct 2012 ZJRMS 2013; 15(2): 1-7</p> <p>Keywords: Morbid Obesity Adolescence Surgery</p> <p>*Corresponding author at: Department, Dept of Social Medicine, Faculty of Medicine, Occupational and Environmental Health Center, Rafsanjan University of Medical Sciences, Rafsanjan, Iran. E-mail: zinatsalem@yahoo.com</p>	<p>Background: Surgical intervention has been recently advocated in the treatment of morbid obesity. The objective of this study was to review surgery as an alternative in the treatment of morbidly obese adolescents.</p> <p>Materials and Methods: This research was conducted by searching English websites such as PubMed, Up to Date, and Google Scholar, as well as some Persian websites including SID, Iranmedex, and Magiran. Articles published from 2000 to 2010 on interventional and clinical trials were reviewed for treatment of morbid obesity in adolescents. Keywords used in internet searches include obesity; adolescence; and surgery.</p> <p>Results: The results obtained from the studies indicated that 4% of American adolescents suffer from morbid obesity. So far, pharmacological treatment and other approaches toward this type of obesity have been inefficient. Hence, surgery was employed as one of the new approaches to the treatment of this disorder. According to the National Health Institute criteria, in the treatment of adolescent candidates for surgery, anthropometric measurements are performed together with the measurement of other co-morbidities of obesity. Adolescents whose percentiles are ≥ 99 are considered as morbidly obese patients.</p> <p>Conclusion: The results of the studies suggested that for the extremely obese adolescents, who do not respond to other types of medical interventions within 6 months, surgery can be performed. Adolescents with BMI of ≥ 40 kg/m² and skeletal maturity, or those with co morbidities of obesity, or 13-year-old girls and boys ≥ 15 years of age can be candidates for surgery. However, the side effects of obesity should not be neglected. Therefore, before the adolescent obesity become morbid obesity, preventive measures should be taken through changes in lifestyle.</p> <p>Copyright © 2013 Zahedan University of Medical Sciences. All rights reserved.</p>

Introduction

According to the standard life insurance tables, extreme obesity is defined as BMI ≥ 45 kg/m², which is equal to a weight 100% more than the ideal weight. Recently, using this system, morbid obesity is classified as having a BMI ≥ 40 kg/m² or BMI of 30 or higher and presence of co morbidities of obesity [1]. Morbid obesity is a serious health problem that occurs frequently and often in the younger age groups [2]. Recently, the prevalence of morbid obesity has been drastically increased even in the children [3].

The most common consequences of obesity include risk of the onset of immature diseases, increase in mortality in the later periods of life, and public health problems [4]. In obese children, the risk of the onset of metabolic syndrome, type II diabetes, and cardiovascular disease is higher [5], so that a survey indicated that 6.5% of obese children in ages 8 to 11 years had ≥ 3 factors of metabolic syndrome [6]. In another study, 3.9% of the obese adolescent girls had metabolic syndrome [7]. Recently, 45% of the newly recognized diabetic patients [8] are children and adolescents. In addition, the left ventricular hypertrophy, atherosclerosis [9], sleep apnea, gallstone disease [5], and non-alcoholic fatty liver disease are also

some of the consequences of obesity [8, 9]. From the social point of view, the most important side effects of obesity in children are social isolation and withdrawal. In addition to the health effects, another problem is the increasing cost of health care and treatment. The cost of medical health care for obese children was estimated to be around 75 billion dollars in 2003 [9, 10].

It was estimated that by 2010 about 41%, 38%, 27%, and 22% of children would be obese in the eastern Mediterranean, the European, the Western pacific, and the southern Africa areas, respectively. It is also anticipated that in the 3 to 4 coming years, approximately one in every ten children in the eastern Mediterranean and European areas will suffer from overweight. Based on these studies, in the United States one out of every seven children is estimated to be obese [10]. In the two studies in the south east of Iran, it is reported that the prevalence of obesity in children and adolescents is 21.1% and 13.6%, respectively [11, 12]. The prevalence of overweight and obesity among adolescents from Yazd province was 16.7% [13]. It was also reported that 15.2% and 26.7% of girls in northern Tehran and in southern Tehran, respectively, suffer from obesity [14]. Moreover,

14.8% and 5.3% of adolescent girls in Lahijan were overweight and obese, respectively [15]. In the Tehran lipid and glucose study (TLGS); it was revealed that 15%, 4.2% and 4.6% of the adolescents were at risk of overweight, obesity and extremely obesity, respectively [16]. In Mashhad, 11.5% and 10.3% of the adolescents were diagnosed with overweight and obesity, respectively [17]. Because the obesity is associated with complications and problems, therefore, effective treatment strategies should be considered and reviewed.

Although behavioral therapy could lead to a weight loss of 1 to 4 kilograms, at the end of the study the participants would remain obese [18]. The strategies for the treatment of obesity have been developed worldwide, pharmacotherapy can be chosen as an alternative method for obese children when lifestyle changes are not effective. Although few interventional studies have been carried out on some of the approved drugs, the FDA has approved only two drugs, sibutramine and orlistat. These two drugs may contribute to a proper treatment, but long-term effectiveness and safety of the two drugs are still unknown, and side effects of them have also been reported [19]. On the other hand, physicians are still faced with the biggest therapeutic dilemma for treatment of morbidly obese adolescents. According to previous researches, behavioral interventions rarely yield significant results in the treatment of extreme obesity [20]. In addition to prescribing the aforementioned drugs [19], the other approach that can be recommended, in the treatment of morbid obesity and also cases failed to treatment, is surgery. The use of surgical procedures for the treatment of morbid obesity (extreme fatness) dates back to five centuries ago [21]. Since 2000 laparoscopy has been used instead of gastric bypass in the treatment of adolescents [9]. The number of adolescents using this procedure has shown a trend toward gradual increase, so as from 2000 to 2003 the number of adolescent candidates for surgery was tripled [20]. Gastric bypass and gastric banding lead to weight loss, but the cost of these surgeries varies from 8,650 to 25,000 dollars. The high expenses make this procedure unaffordable and impractical for some people [22]. Due to efficacy of this method, therefore, the bariatric surgery was suggested for extreme obese adolescents [21].

Bariatric surgery is the most suitable method for patients aged 50 to 60. Although this surgical procedure improves the co-morbidities of obesity in adults, it is still unclear how much it affects the co-morbidities of obesity in adolescents [18].

According to Schilling, bariatric surgery is only indicative in extremely obese children when no positive response to non-surgical treatments is observed in them [22]. Therefore, due to the increasing prevalence of obesity and its co-morbidities, the difficulties and high expenses associated with the treatment of morbid obesity and the failure in behavioral changes that are made through various diets, increasing physical activity, and applying pharmacologic treatments, this study was aimed to review the surgical procedures that were performed from 2000 to 2010 and addressing their complications and

advantages in the treatment of morbidly obese adolescents.

Materials and Methods

Using English websites such as PubMed, Up To Date, and Google Scholar and Persian websites such as SID, Iranmedex, and Magiran, all the articles published from 2000-2010 on the clinical trials and quasi-experimental studies carried out by different surgical procedures were searched. The following keywords were used in this search: morbid obesity, adolescence, and surgery. The three English websites provided good results and almost 100 articles were found. Of these 100 articles, 20 articles that contained the reports of clinical trials were accordingly included in this research. No articles on the surgical procedures for the treatment of obese adolescents were found in the Persian websites, but some of Persian literatures were cited to raise some of issues in the introduction of the article. In order to cover all the Persian articles, the word "obesity" was exclusively used. This search also yielded another five articles concerning different surgical procedures that have been performed on adults through quasi-experimental studies and clinical trials. Since the patients had to be <18 years of age to be included in this study, the aforementioned studies and trials were not included.

Treatment of Morbid Obesity

The initial diagnosis is important in the treatment of obesity. One of the most commonly used methods is the anthropometric measurement of height and weight which together can yield the body mass index (BMI) according to the following formula: $BMI = \text{Weight (kg)} / \text{Height (m)}^2$.

Measurements of BMI and WC (waist circumference) are used to determine the degree of obesity and fat distribution, respectively. In order to measure the WC of a person a non-stretchable standard tape is utilized. The distance between the lowest rib and the iliac crest (in underwear, standing position) is determined to the nearest 0.5 cm during a normal exhalation.

These are considered as the two primary means in screening the obese children. Measurement of WC helps determine those children who fall into the cardiovascular disease risk profiles [23]. The tables presented by the International Diabetes Federation provide the associated percentiles based on age and sex. Children susceptible to central obesity can be diagnosed according to this information. In these tables, a percentile ≥ 90 (in terms of age and sex) stands for central (abdominal) obesity. The history of surgical treatment of extremely obese children and adolescents, its advantages, and complications are discussed later. The primary operations were performed on obese adults through shortening the digestive tract, but this procedure could cause metabolic disorders. In this procedure, the size of stomach would be reduced to 4.5 times of its size. Gastric bypass, Bilio Pancreatic Diversion (BPD), or Duodenal Switch is another alternative method. In BPD, the size of the stomach is reduced to 2.3 times of its size [21].

In 1991, according to the comprehensive results of the National Health Institute conference, bariatric surgery was introduced as the best surgical procedure for the treatment of extremely obese adults. However, this method was not advocated for the treatment of extremely obese adolescents due to lack of information [9].

Bariatric surgery was considered an effective intervention in the long term for the treatment of adults with BMI more than 40 kg/m² or obese subjects having BMI more than 35 kg/m², who also experienced obesity co-morbidities [24].

In the early years, gastroplasty was the first choice to lower the weight of obese children. This method was significantly more efficient in adolescents than adults [25]. Since 2000, laparoscopy has been used in the treatment of extremely obese adolescents [9]. This trend gradually increased in the treatment of adolescents, such that from 2000 to 2003 the number of adolescent candidates for surgery was tripled. According to common evidence, the psychological and social states of adolescents are improved following the surgery and the consequent loss of weight. Therefore, surgical treatment was approved for extremely obese adolescents as it was considered a more effective procedure for this type of obesity. Bariatric surgery may be more effective in adolescence than adulthood, because this procedure is more applicable, suitable, and safe for adolescents than adults [20].

From 1996 to 2002 the use of bariatric procedure was increased in the United States of America in the treatment of adolescents of ages < 20 years. In other words, today from 23 cases to 73 cases out of every 100,000 adolescents undergo the bariatric surgery.

The trend of using this procedure is noted from 1997-2000/2003 in people < 18 years of age. The results suggest that the estimated number of patients was quintupled during 1997 to 2003 and was increased from 51 to 282 patients ($p < 0.01$). Most of the operations were performed on adolescents in adult hospitals, and more than 100 hospitals performed this procedure in year 2003. 72% of the patients were females with a minimum age of 12 and an average age of 16 years. Hospital complications were occurred in 6% of the patients, but the rate of mortality was zero. The results indicated that the number of this type of surgical operations was increased rapidly in adolescents. Most hospitals performed this procedure without any previous experiments. This investigation suggests that further studies are needed in order to be utilized this surgical procedure as efficiently as possible [22].

In a research carried out by Tsai, 771 operations that had been performed on adolescents were reviewed. According to his survey, adolescents were hospitalized shorter than adults. In addition, the rate of hospital mortality in adults was 0.2% while it was 0.0% in adolescents [26]. Lawson studied the metabolic consequences of one year of operation in two adolescent groups. 13% of the experimental group reported no complications. Nine patients had mild short-term complications, 40 had at least a moderate complication during at least one month,

and 2 had experienced serious complications (including beriberi and death) in the long term.

Although bariatric treatment can be considered as an important approach to weight loss and elimination of obesity co morbidities, it is not known whether bariatric is a useful and proper method for the treatment of adolescents and whether it ensures safety throughout their lives. Because firstly it seems that strong biological mechanisms play a vital role in the development of extreme obesity, and secondly there is the possibility that the use of this procedure in the adolescents may cause unpredicted complications and nutritional consequences. Based on the studies performed on the bariatric surgical procedure and the evidence obtained from adults and adolescents (which are specifically reliable for the adolescents with co morbidities of obesity, such as psychological and medical complications), this method can be recommended as a proper method. Due to the psychological and medical complications, impaired quality of life, and the increase in the health care expenses of obese adolescents, surgical treatment should be considered as a priority, because the studies on the safety and efficacy of the surgery has verified the use of this method in obese adolescents [28].

The high efficacy of surgery (80%), as compared to other treatments (5%), is the most substantial factor in the development of the bariatric method. Today, this surgical procedure is only employed for effective treatment of morbid obesity. Surgical procedures can limit digestion, or induce malabsorption, or lead to a combination of both [21].

Review of Previous Studies

In a cohort study, the metabolic consequences of one year of operation were studied in two adolescent cohorts. The initial results indicated weight changes (30 incidents), and the secondarily results showed metabolic changes (n=24) and complications (n=36). The mean BMI of the operative cohort and non-operative cohort were reduced by 37% and 3%, respectively. In the operative cohort, improvements were observed in biochemical factors such as TG (triglyceride), total cholesterol, FBS (fasting blood sugar), and fasting insulin. This improvement was statistically significant. However, no significant difference was observed between the level of HDL cholesterol and LDL cholesterol across the two cohorts. Thirty-one percent of the subjects in the operative cohort indicated no complications, while 15 patients experienced complications, of which 9 had short-term mild complications, 4 had one moderate complication during at least one month, and 2 had at least one serious complication (including beriberi and death) in the long term.

No mortality or any other complications was observed immediately following the operation. This study suggested a significant post-operative weight loss and metabolic improvement in the adolescent. The extreme obesity co morbidities profile (BMI >40 kg/m²) of the adolescents was considerably comparable to that of the

adults. The limitation concerned was the small sample size of the study, and considerable risks were also detected in this study. Based on the primary experiences achieved in this study it can be said that the hazards caused by surgery can be neglected compared to the health-improving advantages of this method [27].

In the study of Harvey no mortality was observed postoperatively. However, initial complications such as pulmonary embolism, and high- or low- level of infection caused by injuries, wounds, and ulcers was reported. Delayed complications such as small bowel obstruction (SBO) and incisional hernia were also observed and two of the patients experienced delayed mortality (two and six years after the operations). However, the relationship between delayed mortality and surgery seemed probably impossible. Weight loss would last for more than 14 years. This study suggests that in adolescents bariatric surgery is considered reliable and safe. It also brings about significant reductions in weight and improves the patients' perception of themselves and the society [20].

Treadwell et al. examined the bariatric surgical procedure in a review study. In this study, all the surgeries performed on more than three patients under 21 years of age in the surgery centers were investigated. Eight studies examined laparoscopy and gastric banding on 352 patients (BMI=45.8 kg/m²), six studies examined the Roux-en-Y bypass method on 131 patients (BMI=51.8 kg/m²), and other surgical procedures on 158 patients (BMI=48.8 kg/m²) with an average age of 16.8 years (ranged 19 to 21 years of ages). The results indicated that bariatric surgery leads to a significant weight loss but implicates serious and potential complications. The results of obesity co-morbidities seemed show that some complications such as diabetes and blood pressure are eliminated. In sporadic cases complications including the erosion of the band or bond, functional gastrointestinal disorder, hiatal hernia, wound infection, and pouch (gastric) dilatation were reported. In the Roux-en-Y bypass surgeries more severe complications such as pulmonary embolism, shock, intestinal obstruction, post-operative bleeding, severe malnutrition, and exudation of bonds were observed [25].

Nguyen performed a comparative analysis between the open gastric bypass method and laparoscopy. In this study, the sample size included 22,422 subjects with major and demographic criteria (such as co morbidities, duration of hospitalization, re-hospitalization within 30 days, infections, mortality rate, and expenses) were studied. The results suggested that 16,367 underwent laparoscopy and 6,065 experienced open surgery. In the laparoscopy cohort, the duration of hospitalization, and the occurrence of complications, pneumonia, venous re-thrombosis, wound exudation, hospital death, wound infection, and pulmonary complications was less and the treatment expenses were also lower. The two groups had a similar expected and observed rate of mortality. The studies performed from 2004 to 2006 suggested that bariatric surgery is mainly inclined toward the use of

laparoscopy. Furthermore, gastric bypass laparoscopy is as safe as open gastric bypass surgery while also in this procedure the frequency of re-hospitalization within 30 days is less than open gastric bypass surgery [30]. Numerous studies have appraised the level of infection, mortality, and weight loss caused by surgery in the adolescents.

In 2001, in a retrospective study on 15 extremely obese adolescents, indicated no genetic syndromes, which had undergone bariatric surgery were examined. Seven patients underwent vertical gastropasty, five experienced Roux-en-Y bypass surgery, and three underwent jejunoileal bypass surgery (which was performed from 1991 to 1997 and was abolished afterwards). The cases aged 13 to 17 years, their follow-up lasted for 6 years on average, and 9 patients that were accessible had longer follow-ups. In this study, all the procedures were performed by a surgeon using open surgical procedures. Post-operative mortality rate was zero. In one case, the side effects appeared as infectious wounds, in two cases episodes of dumping syndrome were observed but the syndromes were not treated, in one case an episode of hypoglycemia was recorded, and in one case short-term imbalance of electrolytes was observed as a result of jejunoileal bypass surgery. BMI of more than 45% of these patients was declined from 58.8±13.7 to 32.1±9.7 kg/m². The results of this study showed that surgery is safe and reliable for the treatment of morbidly obese adolescents that do not respond to medical treatments [31].

In the research carried out by Greenstein, 3 boys and 11 girls, who had undergone surgical operations, were studied. After the operations acceptable changes in the diet, physical activity, and the weights of these patients were observed. Weight loss in men was more than in women post-operatively. They also achieved more weight loss compared to women in the long term. The follow-up time was equal for men and women, and both groups increased the duration of their physical activities after the operations. Men required more calorie intake than women do, but both groups had a fatty diet. The results obtained from this research indicated that the resection surgery on the stomach of the adolescents is similar to the operations on adults, but sustainment of these changes and the weight loss requires advice from a diet expert who can provide a restricted diet [32].

In one study, 19 adolescents aged 13 to 17 years old who had undergone Roux-en-Y bypass surgery from 1999 to 2001 (BMI=49 kg/m²), were studied. The post-operative follow-up for these patients lasted for more than 10 years (at most). After the operations, in the average follow-up of 5.5 years (1-10 years) the mean BMI reduced to 28 kg/m² (23-45 kg/m²). In study only one subject did not lose enough weight and two subjects even gained weight. No mortality and complications were reported and all the obesity co morbidities were also eliminated. This study suggests that surgical treatment should be used for more adolescents so that the physical and emotional side effects of obesity are minimized [33].

In Meg's study, the quality of life of adolescents that had undergone bariatric surgery was examined. About 30% of these adolescents reported depression symptoms postoperatively, while according to their mothers' reports 45% of them get depressed. Out of them, 21% went under psychotherapy treatment. Bariatric surgery caused adverse effects in the lives of these patients, but these damages were clinically significant in some of them. In order to increase and develop the knowledge of candidates for surgery, this information will be vital to the selection of a proper index and a high quality treatment paradigm [34].

In a prospective study performed in Melbourne, Australia, the gastric banding method and lifestyle alteration method were examined for 50 adolescents aged 14 to 18 years with a two-year follow up. More than 50% of weight loss was observed in 84% of the operative cohort and in 12% of the lifestyle cohort. The average weight loss in the first group was 34 kg while it was 3 kg in the second group. At the end of two years follow up, no signs of metabolic syndrome were observed in the operative group while 22% of the lifestyle group still indicated signs of metabolic syndrome. In addition, life efficiency was enhanced in the operative group while it remained not changed in the lifestyle group [36]. In another study, the medical and clinical complications of 60 adolescents who had undergone gastric banding were followed for three years via telephone. The average BMI was reduced from 43 kg/m² (before operation) to 30 kg/m² (after operation). No mortality or complications were observed 24 hours after the surgeries. However, 10% of cases faced a change in band position and in 2 cases the band was removed due to related problems. This study asserts that this method is safe and satisfactory for morbidly obese adolescents [37].

Discussion

In 1991, the National Health Institute introduced surgery as the only effective way of treating morbid obesity [25]. However, it must be noted that children completely differ from adults in biological, behavioral, social, and developmental growth. Therefore, in order to employ surgical procedures these differences should be considered as well [9]. Before performing the surgical procedures, two or three therapeutic approaches should be used to minimize the risk of surgery [21]. Little information have been published concerning surgical treatment of morbidly obese adolescents, but according to the National Health Institute criteria, the following approach is suggested for adolescents aged 12 to 18 years, who candidate for surgical operation. First, anthropometric measurements and evaluations of obesity co-morbidities should be reviewed [35]. To develop the bariatric surgical procedure no decisive criterion exists, but the surgeon and the patient shall consult before the operation. Then, based on the obtained information and by the cooperation between the physician and the patient

a proper surgical procedure should be performed [21]. In some studies, the use of bariatric method has led to the onset of depression and a decrease in quality of life, while it has caused a decrease in the onset of type II diabetes, heart diseases, and obstructive sleep apnea. Although the complications of this method have been fewer in the adolescents compared to the adults, its long-term complications remained unrecognized [9].

Patients who present for surgery should be screened and selected based on their age, BMI, co morbidities, mental status, and quality of life. But the questions are: Are the advantages and risks of different surgical procedures similar in both adolescents and adults? Does surgery affect bone health and height growth? What are the long-term effects of surgery on patient's mental status? Is there any means of predicting which procedure has the most advantages and the least risks for each particular patient? What are the efficient and inefficient predictors? And how do the combined approaches (e.g. surgery and pharmacotherapy, or surgery and behavioral and environmental interventions) work? Does the weight loss mechanism differ from the mechanism of eliminating obesity co morbidities? How do the decisions have to be made in order to be compatible with the available insurance coverage?

The impact of different surgical procedures in combination with behavioral approaches should be determined and the safety of parameters such as mental factors, height, and bone mineral density (BMD) should be assessed [9]. The economic results of the bariatric surgical method indicate that the rate of private insurances has increased. Moreover, due to the increasing trend of the medical costs, all the effective primary cares and preventive measures should be taken in order to prevent epidemic obesity [24]. From 2004 to 2006, bariatric surgery has moved toward laparoscopy. Moreover, gastric bypass laparoscopy is as safe as open gastric bypass and decreases re-hospitalization of patients within 30 days (compared to open gastric bypass) [30].

Surgery through resection of the stomach of obese adolescents is similar to that of adults, but in order to sustain the changes and maintain the weight loss a diet expert should be consulted and restrictions should be put on the diets of the patients [32]. Some researchers suggest that surgical treatment should be used for more adolescents to minimize the physical and emotional complications of obesity [33]. It seems that performing the surgical procedures needs a great deal of effort to be made so that the post-operative re-hospitalization, monitoring, and follow up durations will be based on the patient's development and progress. The patient's decision-making capacity, family structure and obstructions should be analyzed, and the harmful and hazardous medical and psychological consequences should be minimized as well. It is necessary to send the surgical candidates to surgery centers with strong administrations. These centers should be capable of commenting on the adolescents' needs. Surgeries should also be performed in institutes equipped for meeting the

health care needs of the patients. These institutes should also record and report clinical consequences of operations in the long run [35].

Considering the associated complications it is recommended to perform the bariatric procedure through laparoscopy on large sample patients in different countries by pediatric surgeons. The post-operative complications should also be addressed by the suggested solutions and a new reliable approach. In addition, the increase in the support from the social and health insurances can reduce the financial load that is imposed on families of the patients.

Although surgery is considered as an important approach to treatment, the results of the reviewed studies suggest that morbidly obese adolescents who do not respond to behavioral, dietary, and weight loss treatments 6 months following surgery, and yet experience obesity; or adolescents with the same anthropometric, medical, and psychological indications; or adolescents with BMI >90 kg/m² and skeletal maturity; or obese children with co morbidities, or 13-year-old girls and boys older than 15 years old, can be considered proper candidates for surgery because weight loss can stabilize the recovery from co morbidities of obesity. Although bariatric surgery can be employed as an important approach to weight reduction and elimination of the co morbidities of obesity, it is unclear whether this procedure is useful and appropriate for subsequent periods of the lives of operative adolescents or not: because first, it seems that strong biological mechanisms play an important role in the development

of extreme obesity and secondly, this surgical procedure, if performed on adolescents, can cause unpredictable nutritional complications and consequences. Furthermore, according to the complications that are revealed in the studies, it is recommended to perform surgeries in institutions that are equipped for meeting the health care needs of the patients and can record and report clinical consequences of operations in the long run. In addition, since Iran is going through a nutritional transition, the following recommendations should be taken to prevent obesity in adolescents: building exercise into their schedules, education, using the health eating pyramid, balancing calorie intake for weight loss and limit class 1 and 2 obesity, and keeping weight of adolescents in normal range. But if an adolescent, who is diagnosed with morbid obesity, does not respond to behavioral interventions and thus surgery is inevitable, it is on the physician to explain clear all associated operative and post-operative complications for the adolescent and his/her family so that the family and the child manage to make the final decision.

Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

Funding/Support

Tarbiat Modares University.

References

1. Brolin RE. Bariatric surgery and long-term control of morbid obesity. *JAMA* 2002; 288(22): 2793-6.
2. Lujan JA, Frutos MD, Hernandez Q, et al. Laparoscopic versus open gastric bypass in the treatment of morbid obesity: A randomized prospective study. *Ann Surg* 2004; 239(4): 433-7.
3. Treadwell JR, Sun F, Schoelles K. Systematic review and meta-analysis of bariatric surgery for pediatric obesity. *J Am Coll Surg*. 2008; 206(1): 1-
4. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: Public health crisis, common sense cure. *Lancet* 2002; 360(9331): 473-82.
5. International Diabetes Federation. The IDF Consensus definition of the metabolic syndrome in children and adolescents. [Http://www.IDF.Org/webdata/docs/Mets-definition-children](http://www.IDF.Org/webdata/docs/Mets-definition-children).
6. Greenstein RJ, Rabner JG. Is adolescent gastric restrictive anti obesity surgery warranted? *Obes Surg* 1995; 5(2): 138-44
7. Salem Z, Vazirinejad R. Prevalence of obesity and metabolic syndrome in adolescent girls in South East of Iran, 2007. *Pakistan J Med Sci* 2009; 25(1): 384-90.
8. Barshop NJ, Sirlin CB, Schwimmer JB and Lavine JE. Review article: Epidemiology, pathogenesis and potential treatments of pediatric non-alcoholic fatty liver disease. *Aliment Pharmacol Ther* 2008; 28(1): 13-24.
9. National Heart Lung and Blood Institute. Working group report on future research directions in Barshop NJ, Sirlin CB, Schwimmer JB and Lavine JE. Review article: epidemiology, pathogenesis and potential treatments of pediatric non-alcoholic fatty liver disease. *Aliment Pharmacol Ther* 2008; 28(1): 13-24.
10. Salem Z. Anthropometric characteristics in primary school children by using Body Mass Index and Waist Circumference in Rafsanjan, 2008. *J Kerman Univ Med Sci* 2011; 18(1): 40-8
11. Salem Z, Vazirinejad R. Evaluation of anthropometric features in adolescent girls of Rafsanjan. *Iran* 2007. *J Hormozgan Univ Med Sci* 2009; 13(1): 47-53.
12. Mozaffari-Khosravi H, Hosseinzadeh-Shamsi-Anar M, Shariati-Bafghi SE. Prevalence of eating disorders and obesity in high school girl students in Yazd, 2010-2011. *Toloo-e-Behdasht* 2011; 10(1): 38-49.
13. Abtahi M, Djazayeri SA, Eshraghian MR, et al. Overweight, obesity and some related socio economic factors among adolescent girls in Tehran, Iran. *Toloo-e-Behdasht* 2011; 10(1): 38-49.
14. Bazhan M, Kalantari N. Association of anthropometric indices with some dietary factors of high school girls in Lahijan. *Iran J Endocrinol metab* 2009; 11(2): 159-67.
15. Chiti H, Hoseinpanah F, Mehrabi Y and Azizi F. The prevalence of metabolic syndrome in adolescents with varying degrees of body weight: Tehran lipid and glucose study (TLGS). *Iran J Endocrinol Metab* 2010; 11(6): 625-37.
16. Dahri M, Safarian M, Hajifaraji M, et al. The association of overweight and obesity with menarche age and

- nutritional status in girls aged 11-15 in Mashhad. *Med J Mashad Univ Med Sci* 2011; 53(4): 245-53.
17. Inge TH. Bariatric surgery for morbidly obese adolescents: Is there a rationale for early intervention? *Growth Horm IGF Res* 2006; 16(Suppl A): S15-9.
 18. Salem Z, Rezaeian M. Interventional drug therapy. *Zahedan J Res Med Sci* 2011; 10(3): 41-57.
 19. Inge TH, Xanthakos SA, Zeller MH. Bariatric surgery for pediatric extreme obesity: Now or later? *Int J Obes (Lond)* 2007; 31(1): 1-14.
 20. Pasnik K, Najdecki M, Koziarski T, et al. New trends in bariatric surgery. *Pol Merkur Lekarski* 2009; 26(155): 539-41.
 21. Schilling PL, Davis MM, Albanese CT, et al. National trends in adolescent bariatric surgical procedures and implications for surgical centers of excellence. *J Am Coll Surg* 2008; 207(3): 458.
 22. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children (Summer). *CMAJ>JAMC>2007; 176(8supple) S1-3*. www.CMAJ.ca
 23. Davis MM, Slish K, Chao C and Cabana MD. National trends in bariatric surgery, 1996-2002. *Arch Surg* 2006; 141(1): 71-4.
 24. Sugerman HJ, Sugerman EL, DeMaria EJ, et al. Bariatric Surgery for severely obese adolescents. *J Gastrointest Surg* 2003; 7(1): 102-8.
 25. Tsai WS, Inge TH, Burd RS. Bariatric surgery in adolescents: Recent national trends in use and in hospital outcome. *Arch Pediatr Adolesc Med* 2007; 161(3): 217-21.
 26. Lawson ML, Kirk S, Mitchell T, et al. Pediatric bariatric study group one-year outcomes of Rouxen-Y gastric bypass for morbidly obese adolescents: A multicenter study from the Pediatric Bariatric Study Group. *J Pediatr Surg* 2006; 41(1): 137-43.
 27. Inge TH, Zeller M, Garcia VF and Daniels SR. Surgical approach to adolescent obesity. *Adolesc Med Clin* 2004; 15(3): 429-53.
 28. Grilo CM, Masheb RM, Brody M, et al. Childhood maltreatment in extremely obese male and female bariatric surgery candidates. *Obes Res* 2005; 13(1): 123-30.
 29. Nguyen NT, Hinojosa M, Fayad C. Use and outcomes of laparoscopic versus open gastric bypass at academic medical centers. *J Am Coll Surg* 2007; 205(2): 248-55.
 30. Oude-Luttikhuis H, Baur L, Jansen H. Interventions for treating obesity in children. *The Cochrane Collaboration*. USA: John Wiley & Sons, Ltd Press; 2009
 31. Bariatric surgery for morbidly obese adolescents: Is there a rationale for early intervention? *Growth Horm IGF Res*. 2006; 16 Suppl A: S15-9.
 32. Capellao JF, Capellaol RF. Bariatric surgery in adolescence. Is this the best age to operate? *Obes Surg* 2003; 13(6): 826-32.
 33. Zeller MH, Roehrig HR, Modi AC, et al. Health related quality of life and depressive symptoms in adolescents with extreme obesity presenting for bariatric surgery. *Pediatrics* 2006; 117 (4): 1155-61.
 34. Inge TH, Krebs NF, Garcia VF, et al. Bariatric surgery for severely overweight adolescents: Concerns and recommendations. *Pediatrics* 2004; 114(1): 217-23.
 35. O'Brien PE, Sawyer SM, Laurie C, et al. Laparoscopic adjustable gastric banding in severely obese adolescents: A randomized trial. *JAMA* 2010; 303(6): 519-526.
 36. Yitzhak A, Mizrahi S, Avinoach E. Laparoscopic Gastric Banding in Adolescents. *Obes Surg* 2006; 16(10): 1318-22