Effect of bariatric surgery on metabolic disorders in pediatric age group

An Essay

Submitted for Partial Fulfillment of Master Degree in General Surgery

By

Waleed Abobakr Mohammed
M.B.B.Ch

Supervised by

Prof. Dr. Sameh Abdel Hay Abdel Hamid
Professor of Pediatric Surgery
Faculty of medicine-Ain Shams University

Prof. Dr. Ehab Abdel Aziz El-Shafei
Assistant professor of Pediatric Surgery
Faculty of medicine-Ain Shams University

Dr. Wael Ahmed Ghanem
Lecturer of Pediatric Surgery
Faculty of medicine-Ain Shams University

Faculty of Medicine
Ain Shams University
2013

تأثير جراحات علاج السمنة على إضطرابات التمثيل الغذائى فى الأطفال

رسالة
توطئة للحصول على درجة الماجستير في الجراحة العامة

مقدمة من

الطبيب / وليد أبوبكر محمد
بكالوريوس الطب والجراحة

تحت إشراف

الأستاذ الدكتور / سامح عبد الحى عبد الحميد
أستاذ جراحة الأطفال
كلية الطب-جامعة عين شمس

الأستاذ الدكتور / إيهاب عبد العزيز الشافعى
أستاذ مساعد جراحة الأطفال
كلية الطب-جامعة عين شمس

الدكتور / وائل أحمد غانم
مدرس جراحة الأطفال
كلية الطب-جامعة عين شمس

كلية الطب
جامعة عين شمس
٢٠١٣

Acknowledgment

Before all thanks to ***Allah*** *the most compassionate, the most merciful.*

I would like to express deepest gratitude and appreciation to ***Prof. Dr. Sameh Abdel Hay Abdel Hamid****, Professor of Pediatric Surgery, Faculty of Medicine, Ain Shams University, who had expressed so much sincere care and encouragement.*

I wish to express my sincerest and cardinal thanks to ***Prof. Dr. Ehab Abdel Aziz El-Shafei****, Assistant professor of Pediatric Surgery, Faculty of Medicine, Ain Shams University, for his great support and valuable guidance during this study.*

I would also like to express my great thanks to ***Dr. Wael Ahmed Ghanem,*** *Lecturer of Pediatric Surgery, Faculty of Medicine, Ain Shams University, for his kind, help and encouraging assistance in performing this work.*

Finally*, I would like to thank my family for their generous cooperation and help throughout this work.*

Contents

Subjects	Page
• List of Abbreviations	II
• List of Figures	V
• List of Tables	VII
• Introduction	1
• Aim of the work	6
• Definition of pediatric obesity	7
• Epidemiology of pediatric obesity	12
• Pathophysiology of obesity	15
• Metabolic co-morbidities of pediatric obesity	28
• Bariatric surgery in pediatric age	47
• Types of bariatric surgery procedures	59
• Effect of bariatric surgery on metabolic disorders	109
• Summary & conclusion	131
• Referances	137
• Arabic summary	174

List of Abbreviations

ACTH	Adrenocorticotropic hormone
AGB	Adjustable gastric band
AgRP	Agouti-related protein
AHI	Apnea-hypopnea index
BDNF	Brain derived neurotrophic factor
BIB	Bio-enterics Intragastric Balloon
BMI	Body mass index
BPD	Biliopancreatic diversion
CDC	Centers for disease control and prevention
DHEAS	Dehydroepi- androsterone sulfate
DS	Duodenal switch
EGIR	European Group for the study of Insulin Resistance
EWL	Excess weight loss
FDA	Food and Drug Administration
fl oz	Fluid ounce
FTO	Fat mass and obesity associated gene
GBP	Gastric bypass surgery
GH	Growth hormone
GHS-R	Growth hormone secretagogue receptor
GIP	Glucose-dependent insulinotropic polypeptide
GLP-1	Glucagon like peptide-1
HDL	High density lipoprotein
HDL	High density lipoprotein

HTN	Hypertension
IB	Intra gastric balloon
IDF	International Diabetes Federation
IGF-1	Insulin like growth factor 1
IGS	Implantable Gastric Stimulation
INR	International normalized ratio
IPTH	Intact parathyroid hormone
IR	Insulin resistance
JIB	Jejunoileal bypass
LAGB	Laparoscopic adjustable gastric banding
LFTs	Liver function tests
LRYGB	Laparoscopic Roux-en-Y gastric bypass
LSG	Laparoscopic sleeve gastrectomy
MC3R	Melanocortin 3 receptors
MC4R	Melanocortin 4 receptors
MS	Metabolic syndrome
MSH	Melanocyte stimulating hormone
NAFLD	Nonalcoholic fatty liver disease
NASH	Nonalcoholic steatohepatitis
NCEP/ATPIII	National Cholesterol Education Program/Adult Treatment Panel III
NPY	Neuropeptide Y
OSA	Obstructive sleep apnea
PC1	Prohormone convertase 1
PCOS	Polycystic ovary syndrome
POMC	Production of pro-opiomelanocortin
PYY	Peptide tyrosine-tyrosine

QOL	Quality of life
RYGB	Roux-en-Y gastric bypass
SG	Sleeve gastrectomy
SITU	Single incision transumbilical
SNPs	Single nucleotide polymorphisms
SOS	Swedish Obese Subjects
T2DM	Type 2 diabetes mellitus
VBG	Vertical banded gastroplasty
VLDL	Very low density lipoprotein
WHO	World Health Organization
WLS	Weight loss surgery

List of Figures

Figure No.	Title	Page
1	BMI for age percentile in 2-20 years old boys	**8**
2	BMI for age percentile in 2-20 years old girls	**9**
3	BMI chart	**11**
4	prevalence of obesity among United States children and adolescents aged 2-19 years	**12**
5	An algorithm for the evaluation of an obese child. Physical exam, growth patterns, and the child's age should narrow the scope of the differential diagnosis and dictate appropriate testing	**26**
6	Mechanism of the influence of obesity on cardiovascular diseases and type 2 diabetes	**36**
7	Algorithm for the management of severely obese adolescents	**49**
8	Adjustable Gastric banding	**60**
9	Sleeve gastrectomy	**66**
10	Laparoscopic sleeve gastrectomy	**68**
11	vertical banded gastroplasty	**74**
12	Malabsorptive procedures. A: Jejunoileal bypass (purely malabsorptive). B: Biliopancreatic diversion without duodenal switch. C: Biliopancreatic diversion with duodenal switch and sleeve gastrectomy	**76**

13	Biliopancreatic diversion without duodenal switch	**78**
14	Hess and Hess biliopancreatic diversion with duodenal switch and division of the duodenum (sleeve gastrectomy with duodenal switch)	**80**
15	Surgical procedure and technique applied in Roux-en-Y gastric bypass **(Janey et al., 2009)**	**83**
16	A: Triangular position of trocars in SITU-LRYGB. B: The position of trocars and liver retractor in five-port LRYGB	**86**
17	Change in BMI after gastric bypass	**91**
18	Mini-Gastric bypass	**96**
19	Implantable Gastric Stimulation	**98**
20	Intra gastric balloon	**99**
21	Scheme of the metabolic changes in response to AGB and LSG, whose metabolic effects are mainly dependent on weight loss, and RYGB and BPD, whose metabolic effects are also independent of weight loss	**121**
22	Hypothesis of diabetes resolution after RYGB	**122**

List of Tables

Table No.	Title	Page
1	weight category according to BMI	**10**
2	definition of metabolic syndrome according to the WHO, NCEP/ATP III, EGIR and IDF	**30**
3	Definition of pediatric metabolic syndrome according to the international diabetes federation	**31**
4	Components of metabolic syndrome	**32**
5	Metabolic effects of insulin and consequences of insulin resistance	**35**
6	Incidence rates (and confidence intervals) of diabetes (2002-2003) per 100,000 person-years by age group and race/ethnicity	**38**
7	Selection criteria for WLS in adolescents	**51**
8	Schedule for laboratory monitoring after bariatric surgery. LFTs (Liver function tests), [a] examinations should only be performed after RYGB, BPD, or BPD/DS	**105**
9	Two and 10 year diabetes incidence and remission rates from the Swedish Obese Subjects Study	**111**
10	percentage of patients resolving diabetes following surgical and non surgical procedures	**113**

Introduction

Obesity is defined as abnormal or excessive fat accumulation that may impair health. Obesity is now on the rise in low and middle income countries, particularly in urban settings. Close to 35 million overweight children are living in developing countries and 8 million in developed countries **(Ogden et al., 2010)**.

Obesity now affects 17% of all children and adolescents in the United States. The percentage of adolescents and children who are obese tripled from 1980 to 2008. In 2008 alone, more than one third of U.S. children and adolescents were overweight or obese **(NCFHS, 2011)**.

Body mass index (BMI, the weight in kilograms divided by the square of the height in meters) is a screening tool used to assess body fat. BMI has become the preferred method for defining overweight and obesity in children and adolescents because it is noninvasive, easily obtained, and strongly correlated with total body fat **(Himes, 2009)**.

For patients aged 2 through 19 years, weight status may be determined by plotting the BMI value on the 2000 CDC (centers for disease control and prevention) growth charts, which results in an age and gender specific percentile. In contrast to the adult classification

of obesity, age and gender specific percentiles are used for pediatric patients, since body composition differs for boys and girls and for children and adolescents as they grow **(Barlow, 2007)**.

Obesity is considered if a BMI at or above the 95th percentile or a BMI greater than 30 kg/m2 **(Ogden et al., 2010)**.

As the incidence of childhood obesity has increased, so has the identification of the consequences of obesity in children, including Type 2 diabetes mellitus (T2DM), hypertension, hyperlipidemia, fatty liver disease, premature cardiovascular disease, nonalcoholic steatohepatitis, polycystic ovarian syndrome, respiratory disease (sleep apnea and obesity hypoventilation syndrome), gallbladder diseases, musculoskeletal diseases, orthopedic problems, hyperandrogenism and certain cancers **(Körner et al., 2008)**.

Over 50% of overweight adolescents meet the criteria for the metabolic syndrome (insulin resistance, hypertension, hyperlipidemia and abdominal obesity) **(Gardner et al., 2008)**.

The cornerstone of management for childhood obesity is modification of dietary and exercise habits, decreasing portion sizes, decreasing high calorie food and drinks and decreasing snacks are the most common

dietary recommendations for obese children. Diet modification alone is often not sufficient to achieve optimal weight loss in individuals with morbid obesity. When caloric intake decreases, metabolism slows, resulting in decreased calorie utilization and difficulty achieving weight loss, typically resulting in a maximum weight loss of 5-10%, which is unlikely to be sustained **(Hainer et al., 2008)**.

For individuals suffering from complications associated with morbid obesity, bariatric surgery is recognized as an effective treatment to provide significant weight loss and long term weight control **(De Castro Cesar et al., 2008)**.

In view of the rise in the prevalence of childhood obesity, particularly of cases in which obesity related morbidity is already present at a very young age, implementation of surgical treatment modality in adolescents seems a reasonable and acceptable option **(August et al., 2008)**.

The original bariatric surgical procedure was the jejunocolic bypass. This approach was introduced in 1954 and because of its complications, such as life threatening hepatic failure, cirrhosis and renal failure; it is no longer performed **(Balsiger et al., 2000)**.

Both the jejunoileal bypass and the biliopancreatic diversion were performed in adolescents in the 1970s