Introduction

Obesity is a chronic disease characterised by an increase of body fat stores. In clinical practice, the body fatness is assessed by the body mass index (BMI). BMI is calculated as measured body weight (kg) divided by measured height squared (m^2). In adults (age over 18 years) obesity is defined by a BMI $\geq$ 30kg/m^2 and overweight (also termed pre-obesity) by a BMI between 25 and 29.9 kg/m^2 ***(James, 2008).***

The cause of obesity is complex and multi-factorial. At the simplest level, obesity develops as a result of a period of chronic energy imbalance and is maintained by a continued elevated energy intake sufficient to maintain the acquired higher energy needs of the obese state. Complex interactions between biological (including genetic and epigenetic), behavioral, social, hormonal and environmental factors (including chronic stress) are involved in regulation of energy balance and fat stores ***(Farooqi and O'Rahilly, 2006).***

Ghrelin is a peptide hormone found in oxyntic glands, pyloric glands, and small intestine. Ghrelin increases appetite and fat mass by triggering receptors in the arcuate nucleus that include the orexigenic neuropeptide Y (NPY) neurons. Ghrelin-responsiveness of these neurons is both leptin- and insulin-sensitive. Ghrelin reduces the mechanosensitivity of gastric vagal afferents, so they are less sensitive to gastric distension ***(Hewson et al., 2010).***

Some of the leading causes of preventable death among adults are obesity-related conditions such as heart disease, stroke, type 2 diabetes, and some types of cancer (endometrial, breast, colon). Excess weight also increases the risk of liver and gallbladder disease, sleep apnea, osteoarthritis, and gynecologic problems such as infertility ***(Smith et al., 2011).***

Appropriate management of obesity complications in addition to weight management may include: Nutrition: reduce energy intake by 500-1000kcal/day, Physical activity, Behavioral intervention, Prevention and treatment of co-morbidities, Pharmacotherapy, Bariatric surgery ***(Hainer et al., 2008).***

Surgery is the most effective treatment for morbid obesity in terms of long-term weight loss, improves comorbidities, quality of life, and in the long term decreases overall mortality. Today, the most common surgical techniques are:

1. Food limitation operations (restrictive procedures) such as adjustable gastric banding (AGB), proximal gastric bypass (GBP) and sleeve gastrectomy (SG).
2. Operations limiting absorption of macronutrients (limiting energy absorption) such as biliopancreatic diversion (BPD).
3. Combined operations such as biliopancreatic diversion with duodenal switch (BPD-DS) or distal gastric bypass ***(Sjöström et al., 2012).***

Open bariatric surgery began slowly in the 1950s with the intestinal bypass, which caused weight loss purely by the malabsorption of food. Later Drs. J. Howard Payne, Lorent T. DeWind and Robert R. Commons developed in 1963 the Jejuno-colic Shunt, which connected the upper small intestine to the colon. The laboratory research leading to gastric bypass did not begin until 1965 when Dr. Edward E. Mason and Chikashi Ito at the University of Iowa developed the original gastric bypass for weight reduction. Mason is known as the "father of obesity surgery ***(Sjöström et al., 2012).***

Laparoscopic sleeve gastrectomy (LSG), also known as longitudinal or vertical gastrectomy. It was initially introduced in 1990 as an alternative to distal gastrectomy with the duodenal switch procedure to reduce the rate of complications. Sleeve gastrectomy was first performed laparoscopically by Ren and colleagues in 1999 ***(Frezza, 2007).***

Sleeve gastrectomy is an excellent procedure for the surgical management of morbid obesity. Expected weight loss at 6 and 12 months averages 49% and 56%, respectively. Improvement in co-morbidities of obesity, such as hypertension and diabetes mellitus, has been reported to occur in the majority of patients with resolution in 60-100% ***(Kotidis et al., 2010).***

Laparoscopic sleeve gastrectomy is a new and effective procedure for the surgical management of morbid obesity. Basic understanding of common complications and available treatment options is essential. By early diagnosis and treatment of these complications, patient morbidity and mortality might be reduced ***(Sarkhosh et al., 2013).***

The complications of sleeve gastrectomy can be classified into: acute (within 2 weeks of surgery) which include hemorrhage, leak, deep vein thrombosis, pulmonary embolus and abscess; and late complications which include stricture, nutrient deficiency, Gastro-oesophageal refleux disease (GERD) and gastric sleeve dilatation ***(Sarkhosh et al., 2013).***

Enteric leak is one of the most feared complications following sleeve gastrectomy, as it may rapidly lead to sepsis and potentially death. The reported rate for anastomotic leak after sleeve gastrectomy ranges from 0 to 6% in recent studies. Enteric leak should always be considered in early postoperative patients with fever, tachycardia, hypotension, or low urine output. The most common site of the leak is at the uppermost end of the staple line, at the angle of His. An upper gastrointestinal (UGI) series with water-soluble contrast is generally felt to be the most useful test in demonstrating enteric leakage after sleeve gastrectomy ***(Kothari et al., 2010).***

The risk of postoperative bleeding has been reported to be between 1% and 6% after laparscopic sleeve gastrectomy (LSG). The source of bleeding can be intra- or extraluminal. Intraluminal bleeding from the staple line usually presents with an upper gastrointestinal bleed. extraluminal bleeding include the gastric staple line, spleen, liver or abdominal wall at the sites of trocar entry ***(Albanopoulos et al., 2012).***

Formation of stricture is another potential complication occurring after laparoscopic sleeve gastrectomy. It could present either acutely after surgery due to tissue edema or more commonly in a delayed fashion ***(Sarkhosh et al., 2013).***

Nutritional deficiencies are common after bariatric surgery. The etiology is multifactorial owing to impaired absorption and decreased oral intake ***(Gehrer et al., 2010).***

Gastroesophageal reflux disease (GERD) is a condition seen commonly in the bariatric surgery population. Carter and colleagues performed a retrospective study on patients who underwent laparoscopic sleeve gastrectomy and found 47% of their patients to have persistent (> 30 d) gastroesophageal reflux disease symptoms ***(Carter et al., 2011).***

Late-onset gastric sleeve dilatation occurs when the stomach enlarges over time, resulting in failure of weight loss or weight regain. The incidence of gastric sleeve dilatation may rise up to 4.5% and these patients may require re-operation secondary to weight ***(Katz et al., 2011).***

Aim of the Work

The aim of this work is to spot some light on the early and late complications of sleeve gasterectomy and the basic management guidelines for the treatment of complications after laparoscopic sleeve gastrectomy by early diagnosis and treatment of these complications.

Pathophysiology of Obesity

Definition of obesity

Obesity is a chronic disease characterized by an increase of body fat stores. In clinical practice, the body fatness is assessed by the body mass index (BMI). BMI is calculated as measured body weight (kg) divided by measured height squared (m^2). In adults (age over 18 years) obesity is defined by a BMI $\geq$ 30 kg/m^2 and overweight (also termed pre-obesity) by a BMI between 25 and 29.9 kg/m^2 ***(James, 2008).***

Obesity is a leading preventable cause of death worldwide, with increasing rates in adults and children. Authorities view it as one of the most serious public health problems of the 21st century ***(Barness et al., 2007).***

Obesity is stigmatized in much of the modern world (particularly in the Western world), though it was widely seen as a symbol of wealth and fertility at other times in history and still is in some parts of the world. In 2013, the American Medical Association classified obesity as a disease ***(Matthew, 2013).***

Although it is known that a disturbance of the homeostatic mechanisms controlling energy balance causes obesity, it is less clear how the balance is disturbed, since the mechanisms are very complex and involve numerous systems in the body ***(Sunyer, 2009).***

Relation between energy imbalance and obesity

Fat accounts for 21-37% of the body weight of middle-aged men and women. In case of obese individuals more calories are consumed than expended and appetite does not subsequently reduced to compensate for the increase in energy stores (Fig. 1). The amount of the adipose tissue is tightly regulated through neural and humoral signals transmitted to the brain. Failure of fat cells to send adequate signals or failure of the brain to respond to appropriate signals causes obesity ***(Lutter and Nestler, 2009).***

An effective system for the regulation of energy balance require sensors of energy stores in adipose tissue, mechanisms of relay of information to central control sites (hypothalamus) for subsequent integration, which in turn will determine food intake and energy expenditure ***(Berthoud and Morrison, 2008).***

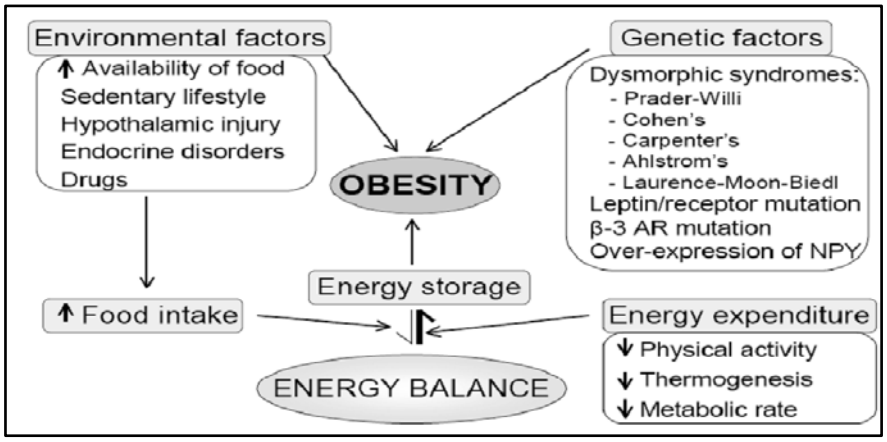

Figure (1): Energy balance and etiology of obesity
(Lutter and Nestler, 2009).

Food intake and energy expenditure regulatory mechanisms

Energy expenditure is determined by physical activity, metabolic rate and thermogenesis. The metabolic side of energy expenditure includes cardio-respiratory work, the maintenance of ion gradients and various enzymatic activities. Physical activity increases energy expenditure by work of the skeletal muscle. The sympathetic nervous system (SNS) affects not only skeletal muscle and cardiovascular system but also thermogenesis ***(Rao, 2012).***

Food intake is regulated by at least four processes: olfactory and gustatory factors, gastrointestinal distension, release of gastrointestinal hormones such as insulin, cholecystokinin (CCK) and gastrin-releasing peptide and activation of thermogenic components of the efferent sympathetic nervous system (SNS) ***(Ochner et al., 2011).***

Many peripheral hormones participate in central nervous system (CNS) control of appetite and food intake, food reward, or addiction. Both palatable foods and drugs are able to activate the mesolimbic dopamine (DA) reward system essential for addiction regulation in humans and animals ***(Liu et al., 2010).***

Factors that contribute to the etiology of obesity

Gastro intestinal hormones and gut peptides

Hunger and satiety signals from adipose tissue (leptin), the pancreas (insulin), and the gastrointestinal tract (cholecystokinin (CCK), glucagon-like peptide-l (GLP-1), peptide YY3-36 (PYY3-36), and ghrelin) are involved in relaying information about energy status through the neural hormonal gut-brain axis primarily targeting the hypothalamus (HPAL) and brainstem, and may directly or indirectly interact with the midbrain DA pathways to impact feeding ***(Lenard and Berthoud, 2008).***

Insulin is a pancreatic hormone critical for maintenance of glucose homeostasis. Insulin levels rise after a meal to keep blood glucose in check. The excess glucose is converted and stored in the liver and muscle as glycogen, and as fat in adipose tissues. Insulin concentrations vary with adiposity, and the amount of visceral fat is negatively correlated with insulin sensitivity. Fasting and postprandial insulin are higher in obese than in lean individuals. Insulin can penetrate the blood-brain barrier and binds to receptors in the arcuate nucleus of the hypothalamus to decrease food intake ***(Maffeis et al., 2008).***

Central insulin resistance may occur in obesity, similarly to the central leptin resistance that is thought to be consequential to high fat consumption or obesity development. A positron emission tomography (PET) study identified insulin resistance in the striatum and insula area of the brain and suggested that such a resistance may require higher brain insulin levels in order to adequately experience the reward and the interoceptive sensations of eating ***(Qatanani and Lazar, 2007).***

Ghrelin, a ligand for the growth hormone secretagogue (GHS) receptor (GHSR), Stomach has been recognized as the richest source of ghrelin produced chiefly by endocrine cells known as P/D1 cells. Ghrelin stimulates the secretion of growth hormone, increases food intake and in turn produces gain in weight. Apart from its effect on growth hormone, it has various important biological actions like regulation of cardiovascular functions, stimulating gastric acid motility and secretion, modulating cell proliferation and survival, energy balance and metabolism. It is also associated with regulation of blood glucose, obesity and sleep wake cycle ***(Surabhi, 2014).***

Leptin, a polypeptide hormone that is produced by adipocytes in proportion to their triglyceride content, links changes in body energy (fat) stores to adaptive responses in the central control of energy balance. By binding to and activating the long form of its receptor in the brain, leptin decreases food intake while increasing energy expenditure. Evolutionary

considerations, together with a large body of experimental data, indicate that a major physiologic role of leptin is to respond to and defend against reductions of body fat that might impair survival and reproductive fitness ***(Myers et al., 2009).***

Adipose tissue secretes leptin in states of food deprivation, exercise and cold exposure. Leptin secretion from adipose tissue is inhibited by obesity states, glucocorticoids, glucose and insulin. Leptin reaches hypothalamus, where in turn it inhibits secretion of Neuro Peptide Y (NPY) that normally reduces energy expenditure, enhances appetite and stimulates synthesis and storage of fat. Adiponectin normally sensitizes tissues for insulin effects. Obesity and insulin resistance negatively regulate adiponectin secretion from adipose tissue, whereas weight reduction enhances its secretion (Fig. 2) **(*Gurevich et al., 2009).***

Leptin also promotes storage and synthesis of fat by an action on lipoprotein lipase in adipose tissue. Leptin acts on other important targets: it increases gene expression of corticotropin-releasing factor (CRF) in the hypothalamus, which reduces food intake ***(Farooqi et al., 2007).***

Plasma leptin is higher in obese subjects compared with normal weight individuals. In fact, leptin concentrations are proportional to body fat mass in both obese and lean subjects. Thus, obesity is not due to the deficiency in circulating leptin. Resistance to leptin might be one of factors in development of obesity. Such resistance could be at the

level of carriage of leptin in the circulation or its transport into the central nervous system (CNS) ***(Myers et al., 2008).***

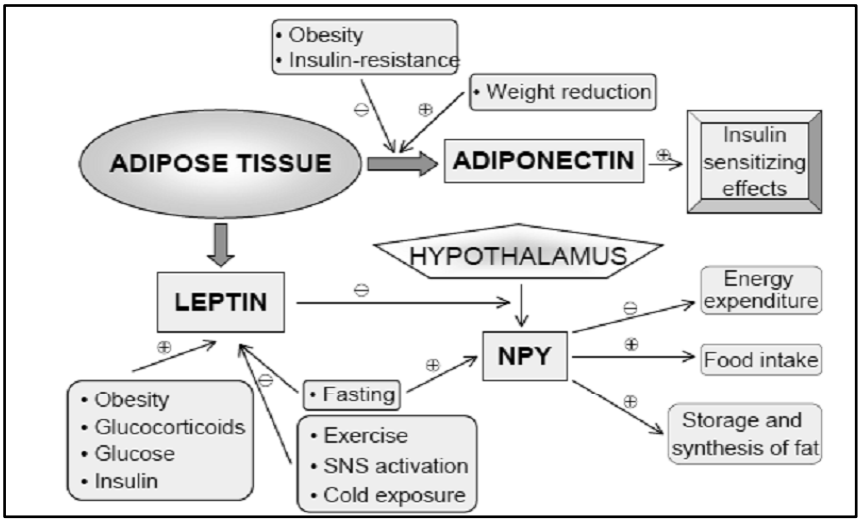

Figure (2): Physiologic regulation and metabolic effects of leptin and adiponectin ***(Gurevich et al., 2009).***

Dysfunctions of mediators other than leptin are implicated in obesity. Tumour Necrosis Factor (TNF), another cytokine that relays information from fat to brain, is increased in the adipose tissue of insulin-resistant obese individuals ***(Mlinar et al., 2007).***

Peptide YY (PYY) is a short, 36-amino acid peptide made in the ileum and colon in response to feeding. Following food ingestion, PYY is released from the L-cells in the distal segment of the small gut. It reduces the rate of intestinal motility and gallbladder and gastric emptying and therefore decreases appetite and augments satiety. Obese

people secrete less PYY than non-obese people and have relatively lower levels of serum ghrelin ***(Valassi et al., 2008).***

Glucagon-Like Peptide 1 (GLP-1) is a key hormone co-released with PYY from the distal intestinal L-cells of the gut after a meal. It is secreted in two equally potent forms, GLP-1 (7–37) and GLP-1 (7–36). GLP-1 primarily functions to stimulate glucose-dependent insulin secretion, enhance β-cell growth and survival, inhibit glucagon release, and suppress food intake. Peripheral administration of GLP-1 decreases food intake and increases fullness in humans in part by slowing gastric emptying and promoting gastric distention ***(Holst, 2007).***

Cholecystokinin (CCK), an endogenous peptide hormone present in the gut and the brain, helps control appetite, ingestive behavior, and gastric emptying via both peripheral and central mechanisms. CCK originating from the gut is rapidly released from the duodenal and jejunal mucosa in response to nutrients' ingestion peaks at about 15–30 min postprandially, and remains elevated for up to 5 h. It is a potent stimulator of pancreatic digestive enzymes and bile from the gallbladder. CCK delays gastric emptying and promotes intestinal motility ***(Arora, 2006).***

In summary, peripheral hormonal signals released from the gastrointestinal tract (ghrelin, PYY, GLP-1, and CCK),

pancreas (insulin), and adipose tissue (leptin) constitute a key component in the gut-brain axis-mediated control of appetite, energy expenditure, and obesity. While leptin and insulin may be considered more long-term regulators of energy balance, ghrelin, CCK, peptide YY, and GLP-1 are sensors related to meal initiation and termination and hence affect appetite and body weight more acutely ***(Murphy and Bloom, 2006).***

Other factors contributing to the etiology of obesity

Genetic research has led to a suggested multi-gene effect, with over 250 genes, markers or chromosomal regions identified that may potentially influence body weight. It has been suggested that genetics can explain 25–40% of the individual difference in adipose tissue. However, although there is evidence that a number of specific genes are associated with excess adiposity these genes commonly interact with the environment to do so. The dysmorphic forms of obesity in which genetics play a major role include the Prader-Willi syndrome, Ahlstrom's syndrome, the Laurence-Moon-Biedl syndrome, Cohen's syndrome, and Carpenter's syndrome ***(O'Rahilly and Farooqi, 2006).***

Environmental factors interact with genetic susceptibility in the pathogenesis of obesity. For example, hypothalamic injury from trauma or surgery and destructive lesions in the region of