ejpmr, 2015,2(2),401-416

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 3294-3211

EJPMR

SURGICAL INTERVENTION IN MORBID OBESITY- A REVIEW

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Article Received on 17/01/2015 **Article Revised on 06/02/2015** **Article Accepted on 28/02/2015**

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ABSTRACT

Obesity is a complex condition that often co-exists with under-nutrition in the developing countries. It is associated with serious medical, psychological, economical and social implications, affecting all age groups virtually. It is a major contributor to the global burden of chronic disease and disability. The epidemic of morbid diseases numbers are continuing to escalate. It is strongly correlated with increases in obesity and physical inactivity. The World Health Organization (WHO) sets the most widely accepted classification of obesity based on Body Mass Index (BMI). The need for strategies to prioritise morbid obesity is important to ensure surgical interventions for those most likely to benefit. Additional to environmental, behavioural & medical approaches, surgical intervention provides an important option for treatment. There are many serious medical implications of obesity such as Hypertension, hyperlipidemia, diabetes mellitus, respiratory insufficiency, cardiovascular diseases, cancer etc. bariatric surgery which is originally developed to treat morbid obesity, involves different types Purely Restrictive, Restrictive > Malabsorptive, Malabsorptive > Restrictive and purely Malabsorptive. Their a

KEYWORDS: Morbidity, Obesity, morbid diseases, bariatric surgery.

1. INTRODUCTION

Obesity, a state of excess fat stored in the body, is becoming a substantial health problem in the world, especially the industrialized countries. The prevalence of obesity is increasing rapidly worldwide. With this growing rate, obesity represents a pandemic that if not well managed as well as urgent attention is given to it, it will have a potential impact on individuals' health as well as governments and economies. It is estimated that more than 1.7

billion adults are overweight while at least 300 million of them are considered clinically obese.[1]

A total of 57 million deaths occurred in the world during 2008; 36 million (63%) were mainly due to cardiovascular diseases, diabetes, cancer and chronic respiratory diseases.[2]

Obesity is a complex condition that often co-exists with under-nutrition in the developing countries. It is associated with serious medical, psychological, economical and social implications, affecting all age groups virtually. It is a major contributor to the global burden of chronic disease and disability.[3,4] Obesity brings an economic load expressed in 5.5% to 7.0% of total health-care cost.[5]

1.1 Classification of obesity

There are several definitions and classifications for degrees of obesity. The most widely accepted classification is that of the World Health Organization (WHO), based on Body Mass Index (BMI). The BMI is being defined as the weight of the individual (in kilograms) being divided by the square of the height (in meters). It estimates the ideal weight of the individual based on their height and size.[6]

Table 1: **BMI values and classification of obesity (WHO 2008 classification)**

Classification	**BMI (kg/m²)**
Underweight	< 18.5
Normal Range	18.5 – 24.9
Overweight (pre-obese)	25.0 – 29.9
Obese	≥ 30.0
Class I obesity	30.0 – 34.9
Class II obesity	35.0 – 39.9
Class III obesity	≥ 40.0
Class III obesity is further classified into more descriptive subgroups:	
Severe obesity	*> 35 kg/m²*
Morbid obesity	*> 40 kg/m²*
Super obese	◦ *> 50 kg/m²*
Super	◦ *> 50 kg/m²*
Super- super obese	○ *> 60 kg/m²*

2. PATHOPHYSIOLOGY OF OBESITY

Obesity is a multifactorial condition caused mainly by genetic and environmental factors interaction. It cannot be explained by one theory. Therefore, below are the most commonly accepted theories.

2.1 Hypertrophic versus hyper-cellular obesity

The adipocyte, the cellular basis for obesity, is either increased in number or size in obese individuals. The enlarged fat cells, the so called hypertrophic obesity, are typical of android abdominal obesity. On the other hand hyper-cellular obesity is more typical of people who develop obesity early in their life, during childhood or adolescence. It is also invariably a feature of severe obesity.

Hypertrophic obesity starts usually later in life, namely in adulthood. It responds better to weight reduction procedures and measures. In contrast, hyper-cellular obesity may not respond well through non-surgical measures and interventions.

2.2 Hormonal influences on appetite

Many hormones, in addition to acting as neurogenic signals and neurotransmitters, affect appetite. Melanocortin hormone modifies appetite through its action on melanocortin receptors. Endocannabinoids hormones enhance absorption of nutrients, stimulate lipogenesis and increase appetite.

There are several gut hormones that induce satiety: cholecystokinin, neuropeptide YY (PYY) and glucagonlike peptide-1 (GLP-1). Leptin and amylin are also potent hormones to induce. On contrary ghrelin, which is secreted from the stomach fundus, is a major hunger hormone.

2.3 Odor detection threshold

Feeding behaviour is a complex process in which smell plays an important role. The odor detection threshold, the lowest concentration of a substance that can be detected by an individual, was found to be different when measured in different individuals.[6]

The smelling capacity is reduced by increased circulating insulin, thus reducing the pleasantness of food. Therefore, the action of insulin in the olfactory bulb may affect the satiety process and thus may be of interest clinically in the pathogenesis of obesity.[7]

2.4 Leptin

Leptin, a 167 amino acid peptide that is synthesized in the adipose tissue, plays a major role in body-weight by regulating the satiety signal to the hypothalamus. It thus reduces dietary intake and lipogenisis while modulating carbohydrate metabolism and energy expenditureleading to prevention of weight gain.[8]

Feng et all. Have described that obese individuals actually don't have leptin deficiency, but they are actually resistant to it.[8] Therefore, elevated levels of circulating plasmaleptin are found in these individuals.

3. IMPACT OF OBESITY ON INDIVIDUALS & HEALTH CARE PROVIDERS

Obesity has much burden on governments and health providers. In the United States alone, the annual cost to manage obesity isapproximately $190.2 billion which accounts for 20.6% of national health expenditures, a recent study showed.[9] An obese individual incurs $2741 more in medical costs annually when compared with a non-obese. In addition, the lost productivity because of obesity costs approximately $73.1 billion annually, and about $121 billion is spent each year on weight-loss services and products.[9]

Accounting for 300,000 deaths each year in the USA alone, morbid obesity is projected to be the leading cause of death, overtaking smoking.[10] Dindo and Moorhead concluded that obesity shortens the life expectancy with the increasing BMI, which results in a proportional shorter life span.[11, 12]

4. OBESITY RELATED CO-MORBIDITIES

Obesity is associated with a host of potential comorbdities that significantly increase the risk of morbidity and mortality in obese individuals. Although no cause-and-effect relationship has been clearly demonstrated for all of these comorbdities, amelioration of these conditions after substantial weight loss suggests that obesity probably plays an important role in their development.

4.1 Hypertension

The relationship between hypertension and obesity is well established both in adolescents as well as adults. There is still ongoing research to study the mechanisms through which obesity causes hypertension. It has been found that activation of the sympathetic nervous system plays an important role in the pathogenesis of obesity related hypertension. During the early stages of obesity, the body retains sodium a result of increase re-absorption in the renal tubules. The volume of the extracellular-fluid (ECF) is increased and the kidney fluid apparatus system is re-set to a hypertensive level, consistent with a hypertension status because of fluidoverload. Plasma rennin, angiotensinogen and aldosterone levels significantly increase in obesity. Other humeral factors that may predispose to hypertension include: insulin resistance, leptin and other neuropeptides.[13]

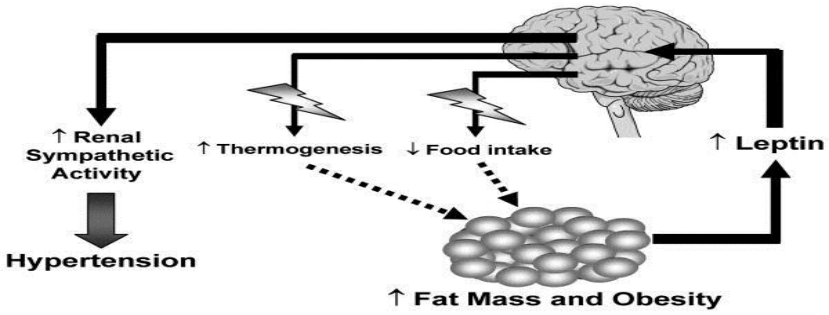

Figure 1: **Shows the mechanism by which obesity causes hypertension** [13]

The understanding of how obesity is linked to hypertension and the exact mechanism, by which it happens, is essential to develop successful strategies for treatment.

4.2 Diabetes Mellitus

Obesity and diabetes mellitus are both major causes of morbidity and mortality worldwide. Evidence from the literature indicates that obesity and overweight are associated with a higher risk to develop diabetes mellitus, and that intentional weight loss helps in reducing that risk. It is estimated that almost 300 000 adults in the US die annually of obesity related causes, and that diabetes is the number six cause of death. Correspondingly, both obesity and diabetes generate immense health care costs.

4.3 Obstructive Sleep Apnoea

Evidence from epidemiological studies suggests that there are links between obstructive sleep apnoea (OSA) and obesity. The pharyngeal airways structure may collapse in patients with OSA, which is due to central fat deposition. The lung volume is reduced due to the excessive fat deposition centrally that may decrease the longitudinal tracheal traction forces and pharyngeal wall tension. The volume of the lung depends on the pharyngeal airway patency, and thus contributes significantly to the development of obstructive sleep apnoea in obese patients [14]

4.4 Reflux Oeshpahgitis: An association between obesity and GERD symptoms has been reported; however, study results have been inconsistent and it is not known whether an association persists after adjusting for other known GERD risk factors.[15]

Overweight and obesity are strong independent risk factor of GERD symptoms and oesophageal erosions. The amount or composition of dietary intake does not appear to be a likely explanation for these findings.

4.5 Cancer

Obesity is one of the important causes of cancer along with smoking. Recently, the obesity-cancer relation has received much attention. Epidemiological research studies have shown that obesity is also associated with increased risk of several cancer types.

Types of cancers that are found to be linked to obesity include: breast, oesophagus, gastric, colon, liver, endometrium, kidney, gallbladder, pancreatic and leukaemia.

It has also been found that obesity may lead to poorer response to treatment and increased mortality related to cancer.

The mechanisms underlying the link between obesity and malignancy are not well understood. These include factors that are related to cellular signalling as well as growth factors.

Table 2: Mechanisms linking Obesity to cancer
Modulation of energy balance and calorie restriction
Growth factors
Signalling pathways
Inflammatory processes

Among the signal pathways that link cancer and obesity is the PI3K/Akt/mTOR cascade, which is considered as a target of many of the factors that regulate the cell proliferation and growth in obesity. Understanding the cellular and molecular mechanisms of the obesity-cancer link is important to develop potential treatment. The relation betweencancer and obesityunderscores the recommendations to maintain a healthy body weight and BMI as one of the most important factors to prevent cancer.[16]

4.6 Osteoarthritis

A study by Losina et al found that knee osteoarthritis due to obesity resulted in a substantial decrease inthe number of quality of life as well as quality adjusted life years.[17]

The overload effect of overweight and obesity on the joint cartilage explains part of the increased risk of developing osteoarthritis in these individuals, especially for the knee osteoarthritis.

Recently, many studies showed the relationship and link between obesity and osteoarthritis. Although there is enough evidence that mechanical factors contribute to thejoint destruction

in obese people, osteoarthritis is considered as a systemic disorder caused by circulating mediators and factors that affect the cartilage and this may explain the diversity of the pathophysiology of osteoarthritis.[18]

5. OBESITY MANAGEMENT

5.1 Medical (non-surgical treatment)

The first step in obesity treatment starts with a comprehensive management of the lifestyle (i.e. diet, physical exercise, behaviour modification).

As obesity is considered as a chronic condition, effective management must a highly motivated individual and a committed health team with good experience in obesity management. This team should be a multi-disciplinary team and may include a physician, a psychiatrist or a psychologist, a physical exercise therapist, a dietician, and other specialists, depending on other comorbdities of that individual patient.

5.1.1 Weight-loss

Weight-loss programmes are systematic and go through phases with the 3 major ones of any successfulprogram are as follows:

- Initial screening phase
- Weight loss phase
- Maintenance phase - This can conceivably last for the rest of the patient's life but ideally lasts for at least 1 year after the weight-loss program has been completed.

Evidence from literature supports the use of a well established weight loss programs. A recent RCT found that commercially available programs used for weight loss are more successful and affordable than those provided by the primary care practice led by specially trained staff.[19]

5.1.2 Pharmacologic therapy

Few pharmacological drugs can be used in obesity treatment. The limitation in their use is that they are used mainly to maintain weight loss rather than producing it. So they are not actually cure, with the advantages and benefits fade when the drug is stopped. As all medications have more risks inherently than exercise or diet do, pharmacological therapy should only be used in individuals in whom the benefits justify the risks.[20]

5.2 Surgical (interventional) treatment:

Surgical intervention for obesity (i.e. bariatric surgery) is the only known therapeutic modality that is associated with a clinically significant as well as a relatively sustained loss of weight in individuals with severe obesity associated with other comorbdities. Published literature shows that well performed bariatric surgical procedures, in selected patients and with a multidisciplinary team approach, is the most effective way to treat obesity and its associated comorbidities.[21]

Although the advantage of bariatric surgery as the only therapeutic method for treatment of obesity and its comorbdities as well as it is associated with significant and rapid weight loss, it is considered expensive and requires resources and well trained surgeons in the bariatric field. Therefore it must be addressed that patients are selected for bariatric surgery, as it still has its risk and complications.[22]

There are few surgical options in bariatric surgery, and as some have become obsolete, others have benefitted from the advances in minimal invasive surgery and the laparoscopic equipments. Below are the commonest performed bariatric procedures, with some are performed as a first stage in severe obese patients (e.g. intra-gastric balloon and LAGB) and others are performed as a definitive procedure (LRYGB and DS).

Bariatric surgical procedures can be classified according to the mode of action into either being: Restrictive, mal-absorptive or mixed.

5.2.1 Intra-gastric balloon

The intra-gastric balloon is considered as a restrictive procedure. It is used as the first step in severe obese patients. The placement and the removal of the balloon are performed endoscopically and under either monitored sedation or general anaesthesia. It is considered to be a temporary measure before performing a more definite procedure. The balloon is usually removed by 6 months after the placement and can be done as an outpatient procedure, by deflating the balloon endoscopically and removing the balloon.

Imaz et al found in their study when comparing the intra-gastric balloon with a placebo that the balloon group had 17.6% excess weight loss compared with the placebo group who lost 1.5% only.[23] Despite its short term results, the patient regains the weight once the balloon is removed which makes its use less desirable.

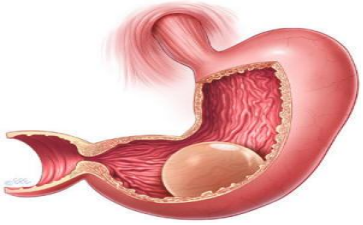

Figure 2: Intra-gastric balloon

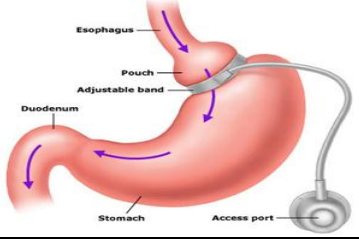

Figure 3:Adjustable Gastric Band

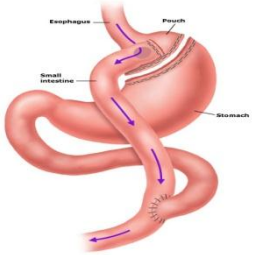

Figure 4: Roux- en- Y Gastric Bypass

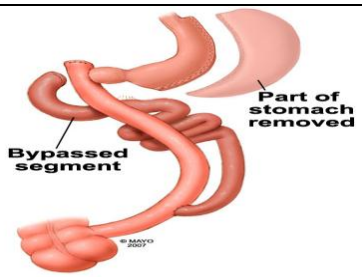

Figure 5: Bypassed segments

5.2.2 Gastric banding

The recent advances in laparoscopic surgery made the adjustable gastric as a potential option for severe or super obese patients, who are at high risk and they don't wish to undergo an invasive irreversible procedure such as gastric bypass. The LAGB is a silicone elastomer band with an inflatable shell form the inside. It is connected by a tube to a port that is placed outside the abdominal cavity for easy access and for adjusting. The inner band diameter can be adjusted by injecting or removing saline from the access port. The band is introduced and placed laparoscopically around the upper part of the stomach approximately 1-2 cm below the oesophagi-gastric junction.[23]

There are many studies that determined the role of LAGB in weight loss; with some have long term results up o 15 years with %EWL of 47%. Despite being minimally invasive, LAGB has its own complications that limit its use.[24]

5.2.3 Gastric bypass

Roux-en-Y gastric bypass (RYGBP) is the commonest performed bariatric surgical procedure. It has been shown to produce a significant weight loss in severe obese patients with studies reporting a weight loss of 60% - 70% of excess body weight. The long-term weight loss has been reported to extend more than10 years in several studies.[25]

Although the perioperative complication rate of RYGBP is acceptable, it is less than ideal. Most bariatric patients have significant comorbdities, increasing their risk of postoperative

complications, especially cardiopulmonary. Apart from being technically challenging, the cardiopulmonary complications make it limited to lower risk patients.

Being a mal-absorptive procedure, patients need a life-long nutrients supplements as well as longer follow-up periods which may have an impact on both the patient and the health provider.

5.2.4 Duodenal Switch

The bilio-pancreatic diversion with a duodenal switch (DS) procedure is a mal-absorptive procedure, with a restrictive component. About 75% of the stomach is resected. This helps to restrict the amount of food ingested. Division and rearrangement of the small intestine is done as the mal-absorptive component of the procedure. As the pylorus of the stomach is left intact, this reduces the dumping syndrome. Technically, this procedure is challenging with a long operative time. The bilio-pancreatic diversion with DS has the highest EWL with some studies reporting up to 75% excess weight loss.

5.2.5 Sleeve gastrectomy

5.2.5.1 Historical background

Laparoscopic sleeve gastrectomy (LSG) was introduced as a restrictive procedure for obese patients, initially described as a possible first-stage operation in super obese patients with body mass index (BMI)>60 kg/m2 or in high risk patients before a more complex definitive procedure.

Afterwards, it has been indicated as a multipurpose definitive treatment in patients with BMI between 35 and 60 kg/m2 associated or not with different medical co-morbidities, and also it has been proposed for patients with moderate obesity (BMI<35 kg/m2) as a restrictive procedure alone. Improvement of diabetes and the metabolic syndrome has been also described, and the results up to now are very successful and similar to the results obtained after classic Roux-en-Y Gastric Bypass. LSG is a bariatric procedure that increased significantly in the United States, Europe, and Latin America.[12] According to the data published by Buchwald and colleagues [26] in United States and Asia, the percentage of LSG increased from 0% in 2003 to 4% in 2008, in Europe from 0 to 7% in the same period and worldwide a mean of 5.3%.

Laparoscopic sleeve gastrectomy (LSG) has rapidly gained popularity as a definitive bariatric procedure despite the sparse long-term follow-up data.

5.2.5.2 Operative Technique in LSG

Although the general steps for performing LSG are the same, there are still some minor variations. To summarise, in general 75% – 80% of the greater curvature of the stomach is excised, leaving a narrow sleeve tube of the stomach.

The technical steps mentioned below is generally considered as the standard technique as described by D'Hondt and colleagues.[22] Still there are some minor variations which are discussed later in this section.

The Setup: The procedure can be performed in any operating room suitable for bariatric patients and equipped with the necessary laparoscopic instruments. Patient preparation includes preoperative heparinization, intra-arterial and central venous lines, nasogastric tube, urine catheter, and customized compression stockings. All pressure points are cushioned. The patient is placed in a steep reverse Trendelenburg position with the knees slightly flexed and hip externally rotated.

The procedure *[22]*

- Prophylactic antibiotics are given pri-operatively.
- The patient is positioned in the French position (Trendelenburg) with the surgeon standing between the legs of the patient.
- Creation of pneumo-peritoneum usually with the veress needle and should be at a pressure of 15 mmHg.
- Five or six trocars are used as described below and as shown in figure (6):
  - A 5-mm subxyphoid trocar serves as a liver retractor.
  - A 12-mm supra-umbilical trocar which serves as an optic system.
  - A 12-mm trocar between the subxyphoidal 5-mm trocar and the supra-umbilical 12-mm trocar serves as both an optic system and a working channel for the linear stapler as well as optic system.
  - A third 12-mm trocar positioned in the left upper quadrant which serves also as a working channel and to retract the stomach.
  - A 5-mm left subcostal trocar positioned in the anterior axillary line.

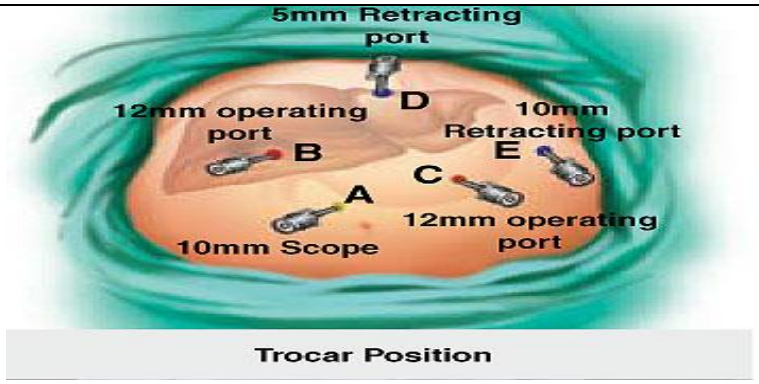

Figure 5:Showing the 5 trocar approach[23]

- The vascular supply of the greater curvature of the stomach is divided starting at a distance of 6 cm from the pylorus and continuing towards the angle of His. This distance is still a controversy as some surgeons go into as small as -3 cm while others go to up to 12 cm [24] the gastroepiploic vessels along the gastricgreater curvature and the short gastric vessels are then divided using the LigaSure device (Covidien, Cincinati OH, USA).
- The adhesions between the posterior aspect of the stomach and the pancreas are divided.
- A 30-40 Fr bougie is introduced by the anaesthesiologist into the stomach for calibrating, and advanced along the lesser curvature of the stomach into the pylorus and duodenum.
- The stomach is then divided using a linear stapler. *Echelon CompactLinear Stapler (Ethicon Endo-Surgery Inc, Cincinatti, OH, USA).*
- A combination of green reloads for the first two firings and then blue reloads for the upper part of the stomach is used. A 2/0resorbable monofilament suture is used over the stapler line to prevent leakage or haemorrhage.

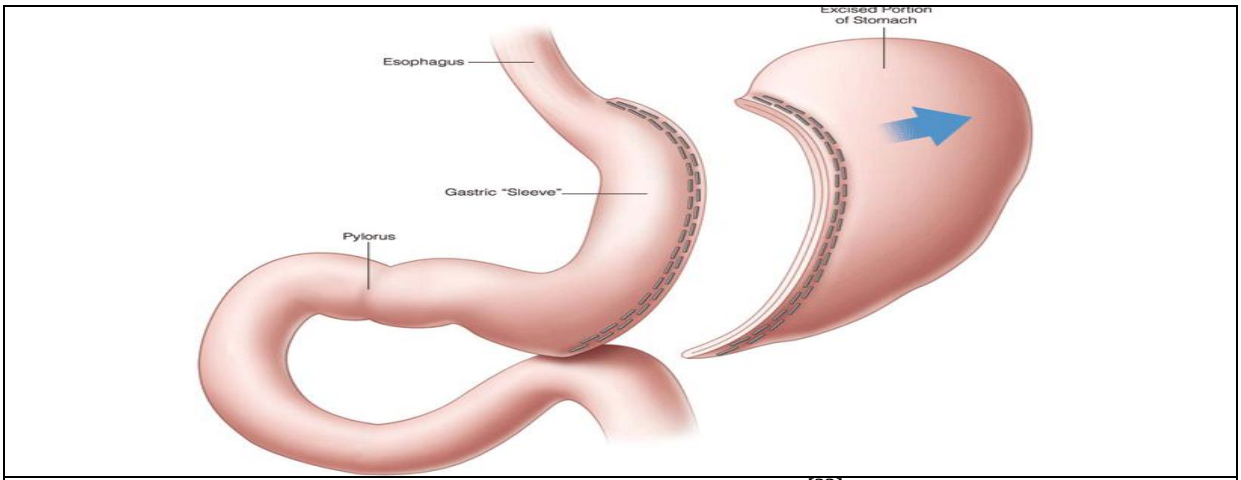

Figure 6: Sleeve Gastrectomy.[23]

- Thereafter, a leak test with methylene blue is used to check the integrity of the stapler line.
- At the end of the procedure, the calibrating bougie is removed and changed to a 18-Fr nasogastric tube.
- A suction drain is placed in the lesser sac, haemostasis is ensured, and port sites are closed.

Controversies in the technique of LSG:
Distance of dissection of the greater curvature from the pylorus
The Bougie size used to create the sleeve
Reinforcement of the division line
Placement of a drain at the end of the procedure

5.2.5.3 Mode of actions of LSG: Previously LSG was considered to be a purely restrictive procedure. Within the last few years it has been shown that LSG is actually a restrictive as well as an endocrine procedure. The mechanism that is involved in weight loss observed after LSG is due to the significant reduction in the stomach size. The use of small calibre bougie provides better results in terms of weight loss. This supports in line with the mechanical role of restriction, which is an important determinant factor in terms for weight loss that can be observed after LSG.[25]

In addition, the hormonal modifications induced by LSG differ from those found after a purely restrictive procedure such as LAGB. More interest was given to the hormonal changes after LSG, specifically the ghrelin hormone. Ghrelin is a potent orexigenic (appetite-stimulating) peptide hormone secreted by the endocrine cells, which reside in the oxyntic glands of the gastric fundus and has been a recent focus of interest.[26] In a prospective study of 20 patients, the effects of LSG on immediate and 6 months postoperative ghrelin levels were compared to that of LAGB. The LSG patients showed a significant decrease in plasma ghrelin levels at day 1 (compared to preoperative levels), which remained low through 6 months. In contrast, in patients who underwent LAGB, plasma ghrelin levels were found to significantly increase at 1 month. Although both procedures are purely restrictive in nature, the superior short-term weight loss experienced by LSG patients may be attributed to the lower ghrelin levels resulting from the additional gastric resection, which may prevent an increase in appetite as a compensatory mechanism.On contrary, Christou et al reported that failing to lose weight after LRYGP is not correlated with the ghrelin levels pre-prandial.[27]

5.2.6 LSG vs. Other Bariatric Procedures

Because of the rising incidence of super-obese patients, interest in less invasive techniques for the treatment of these patients as a bridge to more definitive surgery has increased. The first study to demonstrate superiority of LSG to another weight loss surgical modality was published in 2004. Comparing 20 patients who underwent LSG to historical controls of patients treated with an intra-gastric balloon, superior %EWL at 6 months was observed for the LSG group. Although the endoscopically placed intra-gastric balloon resulted in a % EWL of 24 over this period, LSG obtained superior % EWL (30%) and was better tolerated. In another study comparing laparoscopic LSG to LAGB, again superior % EWL was found after 6 months in the LSG group, 61% vs 29%. It was theorized that the resection of the fundus performed during the LSG reduced a large area of ghrelin producing stomach. The authors found decreased levels of ghrelin in the LSG patients after 1 and 6 months and no change in the levels in the LAGB patients. The removal of large hormonally active areas of the stomach may account for the superior results seen after LSG, but studies with longer follow-up are needed.

Table 3: Benefits of Sleeve Gastrectomy

Lower complications rate
Gastrointestinal continuity and thus no malabsorption
Technically less challenging
Can be converted to other procedures (LRYGB or DS)

6. REFERENCES

1. Deital M. Overweight and obesity worldwide now estimated to involve 1.7 billion people. Obes Surg. 2003; 13(3): 329-30.
2. Alwan A et al. Monitoring and surveillance of chronic non-communicable diseases: progress and capacity in high-burden countries. The Lancet, 2010, 376: 1861–1868.
3. Obesity preventing and managing the global epidemic. Report of WHO consultation. World Health Organization technical report series. 2000; 894:i-xii, 1-253.
4. The global burden of disease: 2004 update. Geneva, World Health Organization, 2008.
5. Thompson D and Wolf AM. The medical-care cost burden of obesity. Obes Rev. 2001; 2: 189-97.
6. Richardson BE, Vander Woude EA, Sudan R, Thompson JS, Leopold DA. Altered olfactory acuity in the morbidly obese. OBES SURG. 2004; 14(7): 967-9.

7. Thompson DA, Moskowitz HR, Campbell RG. Taste and olfaction in human obesity. Physiology & behavior. 1977; 19(2): 335-7.
8. Feng H, Zheng L, Feng Z, Zhao Y, Zhang N. The role of leptin in obesity and the potential for leptin replacement therapy. Endocrine. 2013; 44: 33-39
9. Cawley J, Meyerhoefer C. The medical care costs of obesity: an instrumental variables approach. Journal of health economics. 2012; 31(1): 219-30.
10. Braghetto I, Korn O, Valladares H, Gutierrez L, Csendes A, Debandi A, et al. Laparoscopic sleeve gastrectomy: surgical technique, indications and clinical results. Obes Surg. 2007; 17(11): 1442-50**.**
11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Annals of surgery. 2004; 240(2): 205-13.
12. Moorehead MK, Ardelt-Gattinger E, Lechner H, Oria HE. The validation of the Moorehead-Ardelt Quality of Life Questionnaire II. Obes Surg. 2003; 13(5): 684-92.
13-Rahmouni K. Obesity, sympathetic overdrive, and hypertension: the leptin connection. Hypertension. 2010; 55(4): 844-5.
14. Teai CM, Huang CK. Increase in gastroesophageal reflux disease symptoms and erosive esophagitis 1 year after laparoscopic sleeve gastrectomy among obese adults. Surgical endoscopy. 2013.
15. Vucenik I, Stains JP. Obesity and cancer risk: evidence, mechanisms, and recommendations. Annals of the New York Academy of Sciences. 2012; 1271: 37-43.
16. Losina E, Walensky RP, Reichmann WM, Holt HL, Gerlovin H, Solomon DH, et al. Impact of obesity and knee osteoarthritis on morbidity and mortality in older Americans. Annals of internal medicine. 2011; 154(4): 217-26.
17. Pottie P, Presle N, Terlain B, Netter P, Mainard D, Berenbaum F. Obesity and osteoarthritis: more complex than predicted! Annals of the rheumatic diseases. 2006; 65(11): 1403-5.
18. Hersey JC, Khavjou O, Strange LB, Atkinson RL, Blair SN, Campbell S, et al. The efficacy and cost-effectiveness of a community weight management intervention: a randomized controlled trial of the health weight management demonstration. Preventive medicine. 2012; 54(1): 42-9.
19. Colquitt JL, Picot J, Loveman E, Clegg AJ. Surgery for obesity. The Cochrane database of systematic reviews. 2009(2): CD003641.

20. Imaz I, Martinez-Cervell C, Garcia-Alvarez EE, Sendra-Gutierrez JM, Gonzalez-Enriquez J. Safety and effectiveness of the intragastric balloon for obesity. A meta-analysis. Obes Surg. 2008; 18(7): 841-6.
21. Steffen R. The history and role of gastric banding. Surgery for obesity and related diseases: official journal of the American Society for Bariatric Surgery. 2008; 4(3 Suppl): S7-13.
22. D'Hondt M, Vanneste S, Pottel H, Devriendt D, Van Rooy F, Vansteenkiste F. Laparoscopic sleeve gastrectomy as a single-stage procedure for the treatment of morbid obesity and the resulting quality of life, resolution of comorbidities, food tolerance, and 6-year weight loss. Surgical endoscopy. 2011; 25(8): 2498-504.
23. Nath A, Leblanc KA, Hausmann MG, Kleinpeter K, Allain BW, Romero R. Laparoscopic sleeve gastrectomy: our first 100 patients. JSLS : Journal of the Society of Laparoendoscopic Surgeons / Society of Laparoendoscopic Surgeons. 2010; 14(4): 502-8.
24. Weiner RA, Weiner S, Pomhoff I, Jacobi C, Makarewicz W, Weigand G. Laparoscopic sleeve gastrectomy--influence of sleeve size and resected gastric volume. Obes Surg. 2007; 17(10): 1297-305.
25. Deitel M, Gagner M, Erickson AL, Crosby RD. Third International Summit: Current status of sleeve gastrectomy. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2011; 7(6): 749-59.
26. Buchwald H, Avidor Y, Braunwald E et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004; 292:1724–1737.
27. Christou et al. Sleeve gastrectomy: 5-year outcomes of a single institution. Surgery for obesity and related diseases: official journal of the American Society for Bariatric Surgery. 2013; 9:21-5.