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LONG TERM OUTCOMES OF SLEEVE GASTRECTOMY: A SYSTEMATIC REVIEW

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ABSTRACT

Purpose: Sleeve Gastrectomy is the primary stage procedure before performing an ultimate more complicated procedure. Short and medium term results of sleeve gastrectomy in terms of maintaining weight loss as well as improvement in co-morbidities and lesser complications provide the world with an improved surgical procedure to eradicate obesity. The aim of the study is to examine the long-term results of sleeve gastrectomy. **Methodology:** A thorough and systematic literature search of a number of electronic databases was performed Inclusion criteria for the search comprises of controlled trials, cohort studies and case series. Statistical analysis of the results was performed and displayed as mean, standard deviation and percentage. Correlation of some variables in relation with %EWL using the Pearson coefficient was used. **Results:** There has been improvement or resolution for the major co-morbidities (hypertension, diabetes mellitus, hyperlipidemia and obstructive sleep apnea). On the other hand, in the long term LSG may not improve the reflux. **Conclusion:** LSG is an efficient surgical option for obesity management. The long-term results drawn from this review have been similar to the promising short and midterm results in terms of maintaining weight loss and co morbidities resolution.

KEYWORDS: Sleeve gastrectomy, bariatric surgery, long term effects, obesity, and co morbidities.

INTRODUCTION

Obesity is a condition in which extra fat is stored in the body. Obesity is becoming a substantial health problem in the world, especially in the industrialized countries. The occurrence of the disease is increasing rapidly in the world. With this growing rate, obesity represents a deadly disease, which if not managed well and if urgent attention is not given to it, it will have a potential impact on human well being as well as a significant impact on governments and economies. It is approximated that around 1700 million people in the world are overweight while about 300 million of these people are considered clinically overweight.[1] Obesity is a complex condition that often co-exists with under-nutrition in the developing countries. It is associated with serious medical situations, psychological conditions along with economic and social implications, having an impact on almost all the age groups virtually.[2]

Obesity has burdened governments and health providers. A recent study showed that only in the United States alone, the annual expenditure to manage obesity is approximately $190.2 billion, which accounts for 20.6% of national health expenditures. 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.[6]

Accounting for 300,000 deaths annually in the United States of America alone, the morbidity related to obesity is projected to be the most important source of death and even overtaking smoking.[7] One of the studies also concluded that obesity decreases the life expectancy with the increment in body mass index, which results in a proportional decrease in the life span of an individual.[8,9] Nevertheless, obesity is also related with a host of potential factors of morbidities such as obstructive sleep apnoea, hypertension, diabetes mellitus, GERD symptoms; cancer and osteoarthritis that significantly augment the hazards of morbidity and mortality in obese individuals. The relationship between these factors effecting the morbidity and mortality of an individual and obesity is not significantly clear however, the weight loss related to these factors provided some evidence about the existence of the relation between these factors and obesity. The first step in obesity treatment starts with a comprehensive management of the lifestyle (i.e. Diet, physical exercise, behaviour modification).

As obesity is widely considered as a chronic condition, effective management must be done through educating and motivating individuals and a by creating committed teams of

healthcare professionals 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 factors of morbidity related to obesity.

Surgical intervention for obesity (i.e. Bariatric surgery) is the only known curative modality that is coupled with a clinically momentous level of outcomes as well as a relatively sustained loss of weight in individuals with severe obesity associated with other co-morbidities. Published literature suggests that through successful bariatric surgical procedures in particular patients and with a multi disciplinary panel approach the LSG is the most effective way for treating obesity and its connected co-morbidities.[17]

Although the bariatric surgery procedure is the only therapeutic method for management of obesity and its co-morbidities, the procedure is also used to heel other hazardous factors related with significant and rapid weight loss. However, it requires resources such as well-trained surgeons in the field, and it is considered costly. Therefore, it must be addressed that only specific patients are selected for bariatric surgery, as it still has its risk and complications.[18]

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 frequently utilized bariatric procedures out of which some are performed as a initial phase intervention procedure in severe obese patients (e.g. Intra gastric balloon and LAGB) and others are performed as a ultimate course of action (LRYGB and DS).

Laparoscopic sleeve gastrectomy (LSG) was originally considered as an upgrade on the biliopancreatic diversion (BPD), which was provided with a duodenal switch (DS) in 1998, and was used for the first time laparoscopically in 1999 (Marceau et al., 1998). BPD-DS is made up of a sleeve gastrectomy as a constituent of constraint and then duodenoileostomyas an intestinal bypass. Advantages of sleeve gastrectomy in BPD-DS take account of conservation of the pyloric valve and gastric antrum as compared to distal gasterctomy in criterion BPD, ensuing in decrement in technical hitches related with gastrojejunostomy such as marginal ulceration along with the dumping syndrome. LSG is a bariatric method and the use of the method has increased significantly in the recent years especially in the United

States, Latin America and Europe. According to the published information by Buchwald and the other co authors, the increment in LSG has been extremely significant that is from 0% in 2003 to 4% in 2008 in the United States and Asia region. From 0% to 7% in Europe between 2003 and 2008 and the overall mean of the world also increased by 5.3 %.[21], Lee et al., 2007).

Laparoscopic sleeve gastrectomy (LSG) has quickly built a reputation as an ultimate bariatric method despite the sparse extensive term data availability. The primary study to reveal dominance of LSG to an additional weight loss surgical method was available in 2004. The study compared 20 patients who had utilized LSG against the previous methods of treating patients with an intra gastric balloon, advanced percentage excess weight loss was observed for the LSG group after about six months. The endo scopically placed intra gastric balloon also resulted in an increase in the percentage excess weight loss by 24% over a period of six months however, LSG obtained superior percentage excess weight loss that is 30%. One of the other studies addressing the similar topic and comparing laparoscopic LSG to LAGB also suggests that improved percentage excess weight loss was evident in the LSG group after a period of about six months. The study provided statistical evidence and suggested that laparoscopic LSG vs LAGB in terms of stats can be defined as 61% vs. 29%. In addition, it was theoretically evident that the resectioning of the fundus or upper part of the stomach, which is performed during the LSG, also reduces a hefty vicinity of ghrelin production in stomach. Moreover, the researchers also established that there was a decrease in the levels of ghrelin in the LSG patients. The observations were made after 1 and 6 months however no change in the levels of the gherlin was seen in the LAGB patients. The amputation of hefty hormonally vigorous regions of the stomach is one of the significant causes that provide explanation for the better results evident after the LSG procedure. However, further studies are needed with long term planning and improved persuasion are needed[3,9], Gagner and Boza 2006; Lee et al., 2007).

The main objective of this review is to study the extensive impact on weight loss implications of Sleeve Gastrectomy and to find out if it can be considered as a solitary and definitive bariatric method for the eradication of the disease. The secondary objectives are:

1. To study the impact of sleeve gastrectomy on declaration of the obesity related co-morbidities (hypertension, type 2 diabetes mellitus, dyslipidemia, GERD and obstructive sleep apnea).

2. To study the outcome of the boogie size on the effectiveness of LSG.
3. To determine the correlation between the baseline body mass index and EWL percentage.
4. To determine the correlation between the patient's age at the time of the procedure and the EWL percentage.

METHODOLOGY

Study design

A systematic review approach of published data was used to find out the long-term implications and outcomes of sleeve gastrectomy in conditions of weight loss. The improvement and declaration of the factors of morbidity related to obesity as well as the complications related to these factors. Appraisal and analysis of published studies up to June 2013 was thoroughly studied and maintained throughout the study.

Literature Search

A comprehensive search of published literature in English prior to June 2013 was conducted. Literature search strategy has been applied to the following electronic bibliographic databases:

- Medline (Pubmed)
- Web of Science
- The Cochrane Library

Two reviewers independently using the same keywords have conducted the search. Any duplicate articles or those not meeting the inclusion criteria have been excluded. Literature review was done systematically and the PRISMA flow chart has been followed to get to the number of articles included in the study. The literature search was carried out in two phases.

Phase 1

All studies published in the electronic databases up to June 2013 using the keywords mentioned below, were included. Screening of these articles was done thoroughly by examining the titles and the abstracts.

Phase 2: The full text of all the articles that fit the inclusion criteria and found eligible for the study was thoroughly studied.

Keywords and phrases

To get the relevant information the following keywords have been used in the search

- Sleeve Gastrectomy
- Weight loss
- Long term
- Bariatric surgery

Where appropriate the Boolean operators AND, OR and NOT were used in the search to make the literature search more precise and find relevant articles. No truncation has been used with the keywords.

Study Selection

Explicit criteria were formulated to include and exclude literature to make the study flawless and precise as much as possible. In order to incorporate a literature in the literature review, the research must be up to the mark and should match or surpass all the possible inclusion standards and must avoid all the possible excluding factors. The studies that were excluded might prove to be useful however; those studies, which does not match the inclusion criteria and does not avoid the exclusion criteria were all considered irrelevant and inappropriate and were not utilized in the literature review.

The studies were assessed against strict criteria, which made the process more efficient, time saving and most importantly to increase the affectivity of the research study. This was accomplished trough implicating reliable and understandable rules when assessing the studies that are included in the literature review and to answer the review aim.

Studies that were included had patients with morbid obesity (body mass index >40) or body mass index between 35 and 40 with severe co morbidities (Hypertension, Diabetes mellitus, GERD, Obstructive Sleep Apnoea) who underwent Sleeve Gastrectomy (either open or laparoscopic), where the pre and postoperative body mass index ‘s have been measured as well as % excess weight loss .

Inclusion criteria

Each research needed to be evaluated on the basis of the inclusion criteria formulated when scoping the review. Inclusion criteria for searches were: various controlled trials as well as specific trials, cohort studies (retrospective and prospective) and case series. Articles meeting the inclusion criteria mentioned below have been deemed eligible for the study.

- English language
- Human studies
- Follow up of five years and more
- Primary studies (Case series: >5 patients, rcts and non-randomised trials)
- All age groups, studies published between Jan 2000- Feb 2013
- Patients considered obese with BMI >30
- Reviews (systematic and non-systematic)
- Patients should have had Sleeve Gastrectomy (open or Laparoscopic)

Exclusion criteria

Articles that have not met the inclusion criteria done on animals, or are not in English language or have not been published yet have been excluded. Case reports studies also have been excluded.

- Animal studies
- Case reports
- Not published articles
- Other languages (not in English)

Data extraction and collection

Titles of all eligible articles have been screened and inappropriate articles have been excluded. The abstracts of the remaining articles were read and examined against the inclusion criteria set. The text of the article was reviewed when necessary. The full texts of all papers that were found to meet the inclusion criteria were read and the following data parameters have been extracted:

- Initial BMI & weight
- EWL %,
- Gender (Female: Male)
- Co-morbidities (hypertension, Diabetes Mellitus, GERD, Hyperlipidemia, Obstructive Sleep Apnoea)
- Bougie size
- Complications
- Conversion to other procedures
- Morality

All extracted data has been entered into a spreadsheet Excel (Microsoft, USA). For statistical analysis, the data collected was transferred to SPSS.

Data analysis and presentation

Quantitative analysis of the extracted data has performed to determine average values along with the summarized descriptions of pooled mean, standard deviation (SD) and range, which were discussed in the study. The correlation between the percentage excess weight loss and patient's age, baseline body mass index and bougie size used to create the sleeve was studied using the Pearson correlation coefficient. To study the efficiency of the LSG as a bariatric procedure, the paired t test between the initial (pre-operative) body mass index and the postoperative body mass index was used. The significance was considered if the p value was < 0.05. All statistical analysis was carried out using SPSS-20 software.

RESULTS

Research results

A thorough database search was carried out as stated in the methods section using the keywords and phrases mentioned. Study selected as they meet the inclusion criteria and none of the exclusion ones. The PRISMA flowchart steps were followed throughout in phases, and the results are shown in Figure 1.

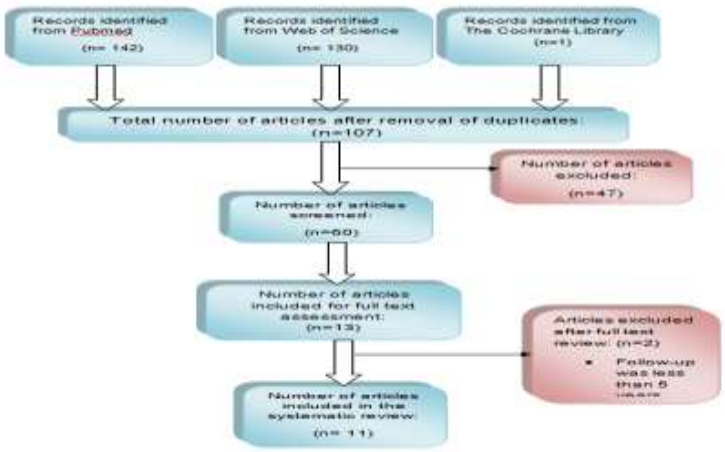

Figure 1 PRISMA Flow Chart Showing The Steps Used In The Literature Search

A sum of about 273 studies was acknowledged using the exploration criteria into three databases (Pub med, Web of Science and the Cochrane Library). After removing the duplicates, 107 studies were screened. Following the appropriate evaluation of the studies on the basis of the exclusion criteria, around 60 studies were selected for abstract review. Out of

the selected studies, only a sum total of 11 were acknowledged and were included in the research using the inclusion criteria after a very cautious and precise viewing and screening of the studies. The included studies consisted of one cohort study while the rest of the 10 studies consisted of single institutions representing their own experiences. The years of publication were between 2007 and 2013.

All studies included patients who underwent sleeve gastrectomy laparoscopically with none reported open procedure.

Studies results

Number of patients and follow up duration

As shown in **Error! Reference source not found.**, total number of patients from all studies is 326 patients, ranging from 6 to 69 patients per study. In one study, total number of their patients were not mentioned (Santoro, 2007). The mean follow-up period for the studies included in this review was 5.6 years (ranging from 5 to 9 years). Most of the units had a mean follow-up of 5 years[6], Weiner, et al., 2007, Santoro, 2007[4], Strain, et al., 2011, Rawlins, et al., 2013, Zachariah, et al., 2013), while some other studies had a mean follow-up of 6 years[13,23] 2010,19. However, another study astonishingly managed to follow their patients for up to nine year (Sarela, et al., 2012). Follow up was reported as 78%, which was calculated on the basis of the response to a questionnaire and self reported weight, QOL (Himpens, et al., 2010). While some studies had a 100% follow-up rate with no patient missed during the follow up period (Rawlins, et al.,2013) while some had a follow-up rate of as low as 40%.

Table 1: Showing Papers, Patients and Follow-up

Paper (Author)	Number of patients (n=326)	Follow-up (yr)
Weiner et al (2007)[23]	8	5
Santoro et al (2007)[27]	NA	5
Himpens et al (2010)[28]	41	6
Bohdjalian et al (2010)[29]	26	5
D'Hondt et al (2011)[21]	27 (23)*	5(6)*
Sarela et al (2011)[30]	17	9
Strain et al (2011)[31]	23	5
Rawlins et al (2013)[32]	49	5
Bragheto et al (2012)[7]	60	5
Zachariah (2013)[33]	6	5
Eid et al (2012)[34]	69	6

Patients' demographics: Gender and age: As shown in **Error! Reference source not found.**, there has been a wide variation in the age of the patients at the instance of undergoing LSG, with the mean age of 44.5 ± 5.8 years (ranging from 34.9 to 52.5).

While some researchers operated in young healthy adults, others managed to perform LSG in patients having age over or around 70 years[21, 28, 34] and the youngest to operate on was 18 years old.[33] As can be seen from the table 2, none has reported any experience of LSG in children or adolescents despite the rising numbers of obesity in that age group.

Only five authors mentioned the female to male ratios in their articles, and majority of those had a 3:1 Female to Male ratio. One of the researchers operated in a group of patients with a 1:1 ratio.[34]

In this review, not all studies reported their initial and postoperative body mass index. All studies reported the percentage excess weight loss, except Weiner.[23] Using the Pearson correlation coefficient, the relation between the mean patients' age and the percentage excess weight loss has been calculated. The p value was found to be 0.259, which is less than 0.05, which is not significant. This means that there is no correlation between the age and the percentage excess weight loss.

Table 2 Showing patients demographics: Age and gender ratio

Paper (Author)	Patients age	Female: Male ratio
Weiner et al (2007)	NA	NA
Santoro et al (2007)	NA	NA
Himpens et al (2010)	44 (28-71)	30 : 11
Bohdjalian et al (2010)	46.2	19 : 7
D'Hondt et al (2011)	40.4 (18-76)	NA
Sarela et al (2011)	NA	NA
Strain et al (2011)	52.3 (39.6-65)	7 : 3
Rawlins et al (2013)	44 (20-65)	7 : 3
Bragheto et al (2012)	NA	NA
Zachariah (2013)	34.9 (18-62)	NA
Eid et al (2012)	50	36 : 33
Paper (Author)	NA	NA

Baseline BMI, post-operative (5 years or more) BMI and %EWL

was found to be 50.1 ± 12.4 kg/m^2 that is ranging from 37 to 66 kg/m^2. While the post operative (5 years or more) mean body mass index ± SD was found to be 37.8 ± 9.9kg/m^2

(range: 27.9 ±55.3 kg/m^2) with a mean percentage excess weight loss of 59.83 % ± 11.38 %, which is believed to be satisfactory by the Reinhold criteria is (Reinhold, 1982).

Table 3 Showing Initial BMI, post-operative (5 years or more) BMI and %EWL

Paper (Author)	Initial BMI	Post-op (5 years or more) BMI	%EWL
Weiner et al (2007)	60.7	NA	NA
Santoro et al (2007)	NA	NA	55
Himpens et al (2010)	39.9	31.1	53
Bohdjalian et al (2010)	48.2	55.3	55
D'Hondt et al (2011)	39.3	NA	64.3
Sarela et al (2011)	45.8	NA	68
Strain et al (2011)	56.1	39.5	48
Rawlins et al (2013)	65	35	86
Bragheto et al (2012)	38.4	29.9	57.3
Zachariah (2013)	37.4	27.9	63.7
Eid et al (2012)	66	46	48

Table 4: Showing Bougie size tube used for creating the sleeve

Paper (Author)	Bougie size, Fr
Weiner et al (2007)	NA
Santoro et al (2007)	NA
Himpens et al (2010)	34
Bohdjalian et al (2010)	48
D'Hondt et al (2011)	30
Sarela et al (2011)	32
Strain et al (2011)	40 (60)*
Rawlins et al (2013)	26.4
Bragheto et al (2012)	NA
Zachariah (2013)	36
Eid et al (2012)	50

Error! Reference source not found. shows the dimensions of the bougie utilized to construct the sleeve during the LSG. Three of the researchers did not mention the size of the bougie they used.[23,27,36] Despite there is not much difference in the surgical technique to perform LSG, the dimension of the bougie utilized to construct the sleeve is still controversial. As shown in **Error! Reference source not found.**, Strain and his co-researchers used a bougie of size 60fr, but they had to change their practice later to size 40fr due to unsatisfactory results in terms of weight loss and weight regained. On the contrary, Rawlins used the endoscope of 26.4fr as the calibrating bougie. The negative correlation (p =.026) was found between the size of the bougie size and the percentage excess weight loss, meaning that the larger the dimension of the bougie, the less percentage excess weight loss.

Error! Reference source not found. shows a negative correlation between the size of the bougie size and the percentage excess weight loss, meaning that the larger the size of the bougie, the less % of excess weight loss**.**

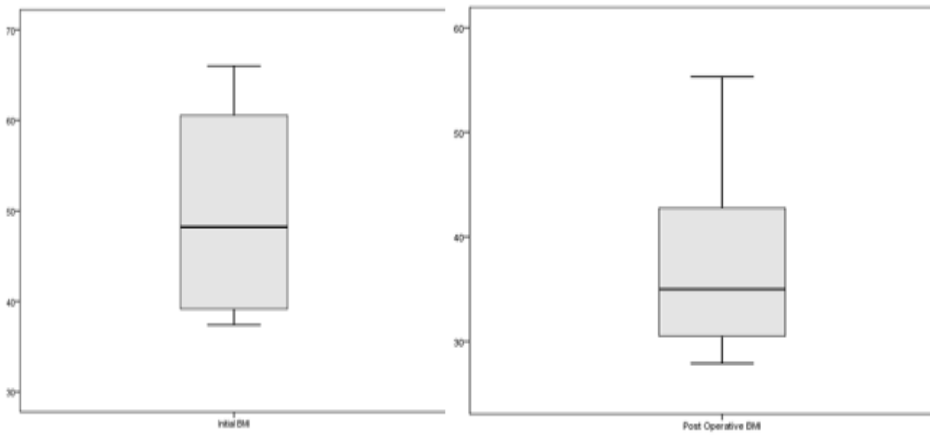

Figure 2: A box plot showing the pre- and post-operative BMI, median, range and 95 CI range. Data is expressed as mean ± SD (range 95% CI)

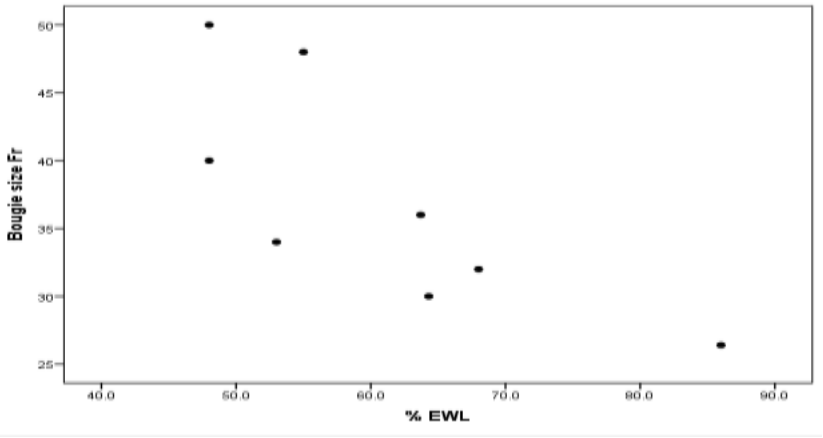

Figure 3: A scattered plot diagram showing the correlation between the size of the Bougie (in French unit) and the % EWL

Table 5: Complications of LSG and mortality

Paper (Author)	Complications		Mortality
Weiner et al (2007)	NA		0
Santoro et al (2007)	NA		NA
Himpens et al (2010)	12.2%	*Leak* *Stensois* *Bleeding*	0
Bohdjalian et al (2010)	NA		0
D'Hondt et al (2011)	0		0
Sarela et al (2011)	NA		NA
Strain et al (2011)	NA		0
Rawlins et al (2013)	1.9% (leak)		0

Bragheto et al (2012)	5.7%	*Leak* *Stricture* *PE* *Bleeding*	0
Zachariah (2013)	4.30%		1
Eid et al (2012)	15%	*PE* *Leak*	0

Error! Reference source not found. shows a summary of the commonest complications post LSG as reported by the authors. Five articles lacked any type of information about their complications. D'Hondt et al reported no complication in their series of patients despite three patients developed strictures, which were managed conservatively and resolved spontaneously without any intervention.[21] Rawlins on the other hand reported one case of staple line leak in one patient (1.9 % leak rate) who was managed conservatively with a drain and TPN.

DISCUSSION

Sleeve gastrectomy was initially the restrictive part in the biliary duodenal switch before it was implemented as a primary step for the elevated threat patients or highly obese patients before considering a definitive procedure. The promising short and midterm results of the sleeve gastrectomy as well as the technical feasibility, especially with advances in laparoscopic surgery, and lower complications rate have led to people considering LSG as a definitive single stage bariatric procedure.

Follow up: Most institutes have reported their short to midterm results as most departments follow patients for a maximum of 24 months. This has led to deficiency in the long term results of such procedure. In this review, all articles in the literature with 5 years or more years of consistent follow up were included. An overall of 11 articles were included in this review, all of which were found to be case series of departments reporting their own experience.

While some researchers managed to get a 100% follow up of their patients like Rawlins and others the other authors managed to get 78% follow-up rate, which is comparable with that in the literature, which is between 30% to 80%.

It has been noticed through this review that some researches either had to follow their patients through a phone call or through a questionnaire sent by post. Despite it had the same questions and information as the office follow-up and the compilation of answers and

information extracted was through a well mannered system still the accuracy of the information filled by the patients could have an impact on the overall results.

Initial BMI and LSG: LSG was first used as principal phase bariatric procedure in extremely obese patients with an initial body mass index of more than 50 kg/m.[2] The promising diminutive term results of sleeve gastrectomy as a solitary course of action have been promising. There were a number of patients who did not opt for second procedure due to satisfactory primary results. The question of the best baseline body mass index to perform LSG is still controversial, but few studies have concluded that a low baseline body mass index is a sturdy interpreter of lower post-operative body mass index.[37, 38] In our review we have noticed the same trend, as the patients who started with a lower body mass index , had a higher percenatge excess weight loss[21,39,46] and those starting with a higher body mass index had lost less weight.[32] On contrary, one of the researchers published the highest percentage excess weight loss of 86% in the literature of LSG with a mean baseline body mass index of 65 kg/m.[2] They have supported their results due to their technique in addition to using a small bougie size (Rawlins, et al., 2013).

LSG and weight loss

Weight loss is assessed as alteration in BMI (Body Mass Index measured in kg/m^2) and ratio of excess weight loss (EWL).

Although short-term results have been promising, and one of the researchers published an excess weight loss after 3 years of 72.8%, after 6 years the excess weight loss had dropped to 57.3% (Himpens, et al., 2010). Despite which according to the Reinhold criteria is still satisfactory according to Reinhold criteria (which states that an EWL greater than 50% is considered satisfactory and a success for the procedure).[33]

Age at time of surgery and %EWL

There is still conflicting evidence if age can be used as a predictive factor to agree on the excess weight loss after any bariatric surgery. In this research, there has been a wide variation in the age of the patients undergoing sleeve gastrectomy with a mean age of 44.5 ± 5.8 years (ranging from 34 to 50 years), with some units operating on patients as old as 76 years.[21] No correlation was found between the initial patient's age at the time of the operation and the percentage of the excess weight loss which means that the p value is greater than 0.05. This was found to be contrary to what is published in the literature previously. In an

investigational study to determine the correlation between the age and weight loss, one of the researchers recruited 337 obese patients of who were younger than 45 while the others were older. The researchers found that there was a significant difference between the age group and the weight loss after one year of follow-up that is the p value was found to be less than 0.001, with better results in the younger age group[12] which has been supported by other studies too.[17]

Bougie Size

The bougie size used to generate the sleeve in the LSG is still controversial. While some authors prefer using a large bougie of size, 50 to 60F others, prefer to use small size bougie. Issues with small size bougie are structure formation, bleeding and leakage. One of the researchers suggested the use of a large bougie to avoid a leakage in the post operative from the staple line.[21] Issues with large sized bougie are unsatisfactory results, pouch dilatation and the need for further procedure, either a re-sleeve or conversion to other procedure is also needed some times.

One of the researchers managed to use the endoscope with a calibre of 26.4 Fr as a bougie. In their series of 69 patients, they reported the highest excess weight loss of 86% despite operating the extremely obese patients with a mean body mass index of 65 kg/m.[2] They had no post surgical problems in terms of leakages or strictures.[32]

In order to support this one of the other researchers are also examined which initially used a size 60 Fr bougie, but due to unsatisfactory results of weight loss and also weight regain, they changed into a small bougie size.[31] This demonstrates that a small calibre bougie size can be used depending on a meticulous surgical technique to prevent leak or bleeding from the staple line. As there is no standard bougie size to create the sleeve.

LSG and Co morbidities resolution

Obesity is related with few co morbidities, that is with hypertension, type 2 diabetes mellitus (T2DM), dyslipidemia (DL) and gastro-oesophageal reflux disease (GERD) being the most common.

The findings in this review are equivalent with the findings and conclusions published in the observed and reviewed literature. Concerning the management of co-morbidities, LSG appears to be an enhanced methodology or resolution for type 2 diabetes mellitus, hypertension and dyslipidemia in comparison to other bariatric procedures namely LAGB.

Between LSG and the LAGB, the improvements could be described as 90% versus 46% in the DM patients, for patients of hypertension is 78% versus 48%, and 87% versus 50% for DL, where as other co-morbidities are also determined at an identical rate. At the moment, for betterment related to co-morbidities. LSG has provided incredibly adequate outcomes in comparison with the laparoscopic Roux-en-Y gastric bypass as it has also provided with the identical high level of outcomes however, this procedure has much higher risks associated to it.

Moreover, another researcher has suggested that the LSG could improve the co-morbidities by 69.6%.[42] However, there is very little evidence in the literature to demonstrate the long-term effects of the procedure and the maintenance of the positive results for 5 years or on the longer run. Most of the published data report satisfactory results in terms of enhancement or declaration of hypertension and type 2 diabetes mellitus up to 3 years of follow-up.

Hypertension

Improvement or declaration of hypertension refers to the stoppage in the anti hypertensive medications or reducing the dose. LSG was found to improve hypertension in 86% of the patients who have had obesity related hypertension and patients have taken lesser medications as a result of the improvement in the hypertension related issues. This is higher than that published in the literature with other studies reporting a rate of 65 to 80%.[43] One of the researchers also reported their experience with 62.5% resolution and 25% enhancement after LSG.[44] In comparison to these figures, other researchers reported only 25% modification in the anti hypertensive medications or resolution in extremely obese patients.[42]

Diabetes mellitus

As diabetes mellitus is one the most common co morbidities associated with obesity and is also considered as a chronic medical condition hence one of the goals to assess the efficacy of a new bariatric procedure is to measure its efficacy to treat or improve obesity related diabetes mellitus. Published papers showed very promising results about LSG resolving type 2 diabetes mellitus in 80% to 85% of the cases. The supposition behind that is postulated for the maintenance of the effects and is not just based on the reduction of excess weight loss, which is supposed to be secondary to the restrictive component of the method, but is based on the hormonal modifications. Studies have shown that the most effective hormone is ghrelin, which was found to decrease after LSG as the fundus of the stomach is removed. The

decrease in the resistance of insulin was found to occur because of calorie restriction. LSG is found to be efficient as a gastric bypass for improvement of type 2 diabetes mellitus.[45] One of the researchers have also suggested that no significant differences in type 2 diabetes mellitus control after 1 year follow up was evident between the two procedures. In this research, the remission rate was 76% of patients who had obesity related type 2 diabetes mellitus and were able to stop their medications and insulin after the procedure.[46]

Dyslipidemia

LSG undoubtedly improves the parameters of lipid profile; however, some of the studies suggest that this tendency is not maintained constantly, particularly after a period of more than 2 years post operatively. One of the researchers in their study indicated that the stumpy levels of HDL cholesterol and the elevated levels of triglycerides are one of the major menace factors for the development of cardiovascular diseases in obese individuals. In this research paper, after 5 years or more of LSG, there has been a significant improvement with a mean percentage of 85.5% resolution in the dyslipidemia. However, in the short term that is before the third month after the surgery the results observed were not satisfying. The outcomes from this review correlate with those published in the literature, which indicate that LSG could also manipulate dyslipidemia related to obesity.[45]

The outcomes of this research are comparable to those published and reviewed in the previous literature, which is 82 to 90%, but one of the researchers also reported that in their experience only 66% improvement was noted. However, studies with huge number of patients are required to determine the impact of LSG on DL patients.

LSG and GERD

Reflux oeshpahgitis and LSG is still a point of controversy. As some surgeons consider a pre-operative GERD a contraindication for LSG, others still recommend these patients to undergo LSG. Unlike other co-morbidities which improve after LSG such as AHT and type 2 diabetes mellitus, which have a remission rate of up to 90% and some studies reported 100% remission rate.[32] Patho physiology involves increase of GERD, which is due to the anatomical changes, which refers to the loss of the sling fibres at the lower gastro oesophageal junction. In this review, there is evidence that GERD improves only in 46% of cases and while some patients require conversion to other procedures, others improve spontaneously.[29]

Hiatus hernia is another important risk factor to develop GERD and its repair has been shown to decrease GERD symptoms after LSG.[49]

One of the other researchers proposed that postoperative follow up endoscopy is also essential to recognize the true prevalence of postoperative GERD. Endoscopy could also reveal the anatomical modification in the gastric tube subsequent to modification in the surgical technique.[12]

LSG complications

The advances in minimally invasive surgery as well as the peri operative patients' care have led to minimizing the number of postoperative complications. LSG like other surgical procedures has its own complications, with some being early and some being long term. In the previous literature, not all the researchers reported complication rate. Nevertheless, from those who reported, the most common early complication was staple line leakage with a rate of 1.9%, which is similar to the published data.[32]

CONCLUSIONS

Obesity is becoming an epidemic problem worldwide and surgical methods have proven to be the best way to maintain weight loss in the extensive term. The results from this review suggest that LSG can be performed as a single and definite bariatric procedure, which induces an acceptable long-term weight loss, as expressed by an overall one hundredth of the excess weight loss of more than 50%, which is comparable to other bariatric methods such as LRYGB and LAGB.

There is an issue with weight regain after the third post operatively year which can be justified either due to the formation of a neofundus and thus increase in ghrelin secretion or due to the pouch dilation. It also showed that LSG is the safest procedure with very minimal morbidity and mortality. The general causes of such complications are staple line leakage and bleeding and both can be prevented by using a good surgical technique as well as choosing the right bougie size. This review has demonstrated the relation among the dimensions of the bougie and the weight loss after LSG, as the smaller the bougie the better the outcome in terms of weight loss, but care should be taken to avoid staple line leak.

There have been satisfactory results of LSG, as shown in this review, in resolving or improving most of the obesity related co morbidities (hypertension, type 2 diabetes mellitus,

dyslipidemia and Sleep Apnoea). The only exception was GERD, which actually some patients develop after undergoing LSG.

LSG can be definitely used as a single definitive bariatric procedure for the management of obesity with satisfactory long-term results in terms of weight loss as well as co morbidities improvement and resolution. More studies are required to determine the best bougie size as well as to standardise the technique. A follow-up protocol should be standard among units that perform LSG and longer follow up is required to pick patients who regain weight and manage them accordingly. Moreover, further researches with long-term follow up are essential to support the results of this review.

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