Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/3267
DOI URL: http://dx.doi.org/10.21474/IJAR01/3267

RESEARCH ARTICLE

WEIGHT REGAIN AFTER SLEEVE GASTRECTOMY

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Manuscript Info

Manuscript History

Received: 03 December 2016
Final Accepted: 11 January 2017
Published: February 2017

Key words:-
Gatric size, sleeve, surgery

Abstract

Background: Gastric size determines the amount of dietary intake which in turn determines energy intake. Body weight loss depends on negative energy balance.

Objectives: The primary purpose of the present study was to assess body weight loss for 36 months in patients who underwent gastric sleeve surgery. A secondary purpose was to examine the impact of gender and age on weight changes before and after surgery.

Methods: A total of 309 patients were enrolled sequentially. Age, body weight, gender, BMI, and comorbidity were assessed before and after gastric sleeve surgery for 36 months.

Results: Results showed that body weight before and after surgery was influenced by both age category and gender. It was also noted that the rate of body weight reduction was faster during the 1st 12 months compared to the 2nd 12 months.

Conclusions: Based on the results of the present study, it can be concluded that prior and post gastric sleeve surgery body weight is influenced by age and gender. The rate of weight reduction after gastric sleeve surgery is faster during the first 12 months, compared to the second 12 months. Gastric sleeve affected body loss and that can be considered as effective treatment for obesity and obesity related diseases.

Introduction:-

Sleeve gastrectomy is a surgical procedure that is performed in overweight individuals in which vertical segmentation of stomach is performed in order to reduce the stomach's surface area so that it greatly helps to modify BMI of an individual. Obesity is related to different morbid metabolic conditions hence sleeve gastrectomy provides an efficient way of reducing mortality in morbidly obese patients. It is performed through open and laparoscopic approach, laparoscopic being the modern way is more reliable. After surgery it depends on the person that how he coupes up with his changing body requirement and eating habits. Once the surgery is performed dietary requirement is reduced to a great extent but bouts of binge eating may stretch the stomach musculature and cause weight regain that may lead to an alarming situation for the person who underwent sleeve gastrectomy once. In certain conditions re sleeve gastrectomy is to be performed keeping in view the weight regain due to unavoidable eating habits. Different researches have been done in different geographical areas of the world and study population includes individuals from both the genders so that results may be applied to general population undergoing sleeve

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gastrectomy. Based on physiology of human body stomach is made up of rogue, these are muscle layers which increases the surface area of stomach and as the person eats it causes a stretch response in the stomach's musculature and it causes an increase in the stomach's size which is reflected as a protruded abdomen. This protruded abdomen significantly depicts weight gain and this is a leading problem to other physiologic and metabolic disorders. Sleeve gastrectomy provides a way to prevent obesity by decreasing the capability of stomach to make room for food and thus decreasing or more appropriately limiting the food absorption. As a result of multiple surgeries multiple cases came forth. Some reported weight regain and some weight loss. All depends upon individual's dietary consumption and metabolic body requirements.

Literature Review:-

Obesity is one of the high risk factor for many other morbidities and with the modern era of industrialization, obesity is expected to increase and the number of the people affected is raising with every passing day thus exposing the obese population to a compromised quality of well-being and health. Super obese patients are those who have a BMI greater than 50kg/m2. They are at a greater risk to develop hypertension, diabetes, arthritis, sleep apnea and pulmonary dysfunction as compared to people with BMI less than 50kg/m2. Obesity has led many people to develop inferiority complexes and psychological problems (Almogy et al., 2004). Sleeve gastrectomy is one of the surgical procedures performed in obese patients as an approach to limit the gain in weight. It is an effective method with little risk of post-surgical complications (Benaiges et al., 2015). Although sleeve gastrectomy is an affective procedure but it has been observed and reported in some studies that it's affects are short term and patients having a BMI greater than 60kg/$m^{2\ have}$ been reported a failure in maintaining a long term weight loss and weight regain has been the most common complication reported so far in many such cases (Regan et al., 2003). Sleeve gastrectomy cannot be considered as the only best surgical procedure for the weight reduction rather several approaches should be collectively employed for better and long term results. Roux-Y gastric bypass is another technique and a combination of both these surgical procedures may be employed to reduce comorbidities and reduce the risk of relapse and weight regain (Yang et al., 2008). Sleeve gastrectomy as compared to all other surgical methods that have been used to reduce the morbidity and obesity by far is the most favorite procedure for the surgeons because it is comparatively less invasive and has a shorter operating time. The risk of post-surgical complications is also less as compared to other methods but the only limitation is the relapse and recurrence because in this technique a part of the stomach is removed and an anastomoses is created with the duodenum thus the volume of the stomach is decreased but weight regain after sleeve gastrectomy is associated with widening or enlargement of the sleeve after surgery with increased capacity of the gastric tube (Weiner et al., 2007). Post- bariatric surgical procedure there is a lifelong threat of being obese again that persists throughout. Eating habits and behavior modulation also plays its role for the solution. Feeling hungry all the time when one urges for food that has high caloric value and low dietary fiber is also one of the problems that led to regain after surgery (Odom et al., 2010). Thus laparoscopic sleeve gastrectomy can be performed as a primary procedure if the aim is to get rid of excessive weight with the least post operating risks (Brethauer et al., 2009). Laparoscopy that has allowed the surgeon to insert a micro camera and made the surgical procedure easy for the surgeon, less invasive for the patient and every fine detail can be visualized through laparoscopy. Laparoscopic sleeve gastrectomy is also being used rather it has revolutionized the procedure and has further served to decrease the risk of per-operating complications and risks. Minor procedural errors can also be reduced and high level of precision can be achieved through laparoscopic surgical procedures (Rubin et al., 2008). Advantages of laparoscopic sleeve gastrectomy also include marked decrees in plasma ghrelin levels, Ghrelin is a growth hormone and is controlled by hypothalamus (Kojima et al., 1999). It is also an important factor for weight loss but the decrease is seen for the initial 6 months after which a stability in the level of ghrelin has been observed thus leading to no further weight loss. Behavior modulation and dietary habits at this stage should be monitored with great care otherwise a weight regain may be seen (Langer et al., 2005). Laparoscopic sleeve gastrectomy is being widely used for treating morbid weight gain. This method advocates lesser restrictions on dietary intake following surgery. Since no prosthetic or foreign materials have been implanted in this surgery so post-operation risk of complications is also greatly reduced which in turn renders this to be a superior method among the others for the treatment of morbid obesity. The only limitation that goes against this bariatric procedure is that it is short term and relapse has been reported in many cases (Skrekas et al., 2008). Nature has blessed us with a body that adapts to different physiologic and pathologic stressors quite well. It stretches under the conditions like excessive intake of food. In sleeve gastrectomy anastomosis of stomach and duodenum is made in such a way that stomach attains a very small size, typically it shapes like a banana. This is a logical observation that a stomach of a very small size will not be able to tolerate much food hence t causes weight loss which is a therapeutic surgery in case of morbidly obese patient. On the

contrary post surgically if the patient is non-compliant and eats junk and fatty food weight regain occurs but obviously this is a time taking procedure and does take a comparatively larger time than usual.

Its other name is roux en Y by pass. By pass means creating an alternative channel. There are specific pre requisites of this surgery to assure the desired results which are not the highlights of the topic under study but yes they do affect the outcome of the procedure under discussion (Kojima et al., 1999).

Indicators of noteworthy postoperative weight recover after bariatric surgery incorporate markers of pattern expanded nourishment inclinations, diminished prosperity, and worries over addictive practices. Postoperative self-checking practices are emphatically connected with opportunity from recapture. These information propose that weight recover can be expected, to a limited extent, amid the preoperative assessment and conceivably lessened with self-observing procedures after RYGB (Odom et al., 2010). Sleeve gastrectomy (SG) is getting noticeable quality around the globe as a bariatric technique both as a first-organize system in high-risk or super fat patients and as a fundamental operation. The potential purposes of enthusiasm of the SG are that it presents provoke control of caloric confirmation, does not require course of action of an outside body or require modifications, and can all around be performed in less time than required for avoid frameworks. The possible downsides of the SG consolidate the irreversibility, extended specialist peril differentiated and other restrictive frameworks, and unproved quality. The explanation behind the present efficient review was to evaluate the current evidence as for weight lessening, trouble rates, postoperative mortality, and co-terribleness a great many SG (Benaiges et al., 2015).Sleeve gastrectomy can be performed safely with commendable entrapment rates and awesome weight decrease. The rate excess weight decrease reported from this course of action of up to 66% at 3 years is engaging. We think about our audit quantifiable limitations as already recorded and the, 'as of recently, minimal patient numbers in the more amplified term. Reasonable examinations will continue with reference to what is the perfect bariatric strategy. Possibly a more supportive open thought could be on the assurance criteria for different sorts of bariatric method with respect to the individual patient's goals, conditions moreover, needs.

Statistical Analysis:-

Data were analyzed by using Statistical Package for Social Studies (SPSS 22; IBM Corp., New York, NY, USA). Continuous variables were expressed as mean ± standard deviation and categorical variables were expressed as percentages. The t-test was used for continuous variables and chi square test was used for categorical variables. Changes were assessed at different study phases compared to baseline levels using adjusted analysis for pricewise comparisons using benferroni correction of repeated measures ANOVA. A p-value <0.05 was considered statistically significant.

Table 1:- Baseline characteristics of the studied sample

	All 306		Male 100(32.68%)		Female 206(67.32%)		p value
	Mean(SD)		Mean(SD)		Mean(SD)		
Age	33.00	(10.86)	31.00	(11.00)	33.97	(10.69)	0.025
Age <25 (%)	92.00	(30.07)	40.00	(40.00)	52.00	(25.24)	
Age 25-34(%)	84.00	(27.45)	28.00	(28.00)	56.00	(27.18)	
Age 35-44(%)	79.00	(25.82)	18.00	(18.00)	61.00	(29.61)	
Age≥45 (%)	51.00	(16.67)	14.00	(14.00)	37.00	(17.96)	
Weight	124.07	(27.27)	146.11	(31.13)	113.10	(16.51)	<0.001
BMI	46.49	(8.46)	49.77	(10.85)	44.80	(6.32)	<0.001
Comorbidities (%)							
HTN (%)	28.00	(9.15)	11.00	(11.00)	17.00	(8.25)	0.434
DM (%)	32.00	(10.46)	14.00	(14.00)	18.00	(8.74)	0.158
Dyslipidemia (%)	10.00	(3.27)	4.00	(4.00)	6.00	(2.91)	0.616
Other (%)	64.00	(63.67)	15.00	(15.00)	49.00	(23.79)	0.076

Table 2:- Long-term Results of Sleeve Gastrectomy for Obesity by gender

Weight	all		Male		Female		p value
	Mean(SD)		Mean(SD)		Mean(SD)		
Before surgery	124.07	(27.27)	146.11	(31.13)	113.10	(16.51)	<.001
After 3 months	110.82	(26.07)	129.31	(30.42)	101.77	(17.72)	<0.001
After 6 months	101.26	(21.15)	113.97	(27.26)	95.72	(14.97)	0.001
After 9 months	92.32	(24.10)	106.89	(34.09)	86.03	(14.66)	0.011
After 12 months	85.92	(20.89)	94.51	(28.76)	81.63	(14.03)	0.039
After 18 months	85.76	(22.86)	94.55	(32.76)	81.76	(15.29)	0.067
After 24 months	82.91	(21.22)	97.29	(30.56)	77.71	(13.71)	0.02
After 30 months	78.53	(15.96)	70.92	(13.44)	80.77	(16.12)	0.086
After 36 months	84.44	(21.20)	102.99	(20.97)	79.05	(18.27)	0.002
After 48 months	89.66	(28.54)	103.70	(32.90)	81.93	(23.22)	0.04
After 60 months	81.31	(21.62)	81.33	(8.76)	81.30	(24.26)	0.998

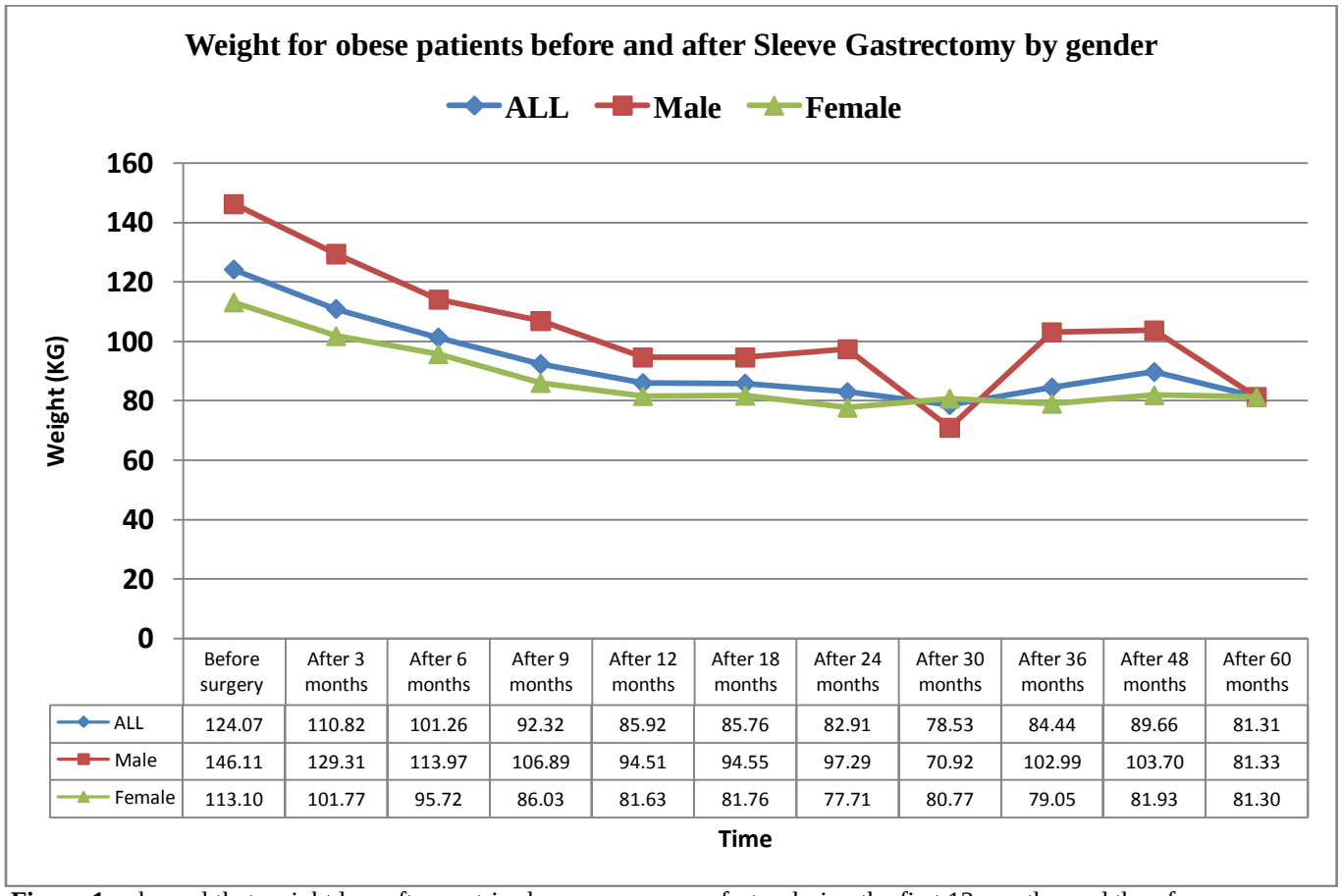

Figure 1:- showed that weight loss after gastric sleeve surgery was faster during the first 12 months, and then from the second year the rate of weight reduction decreased until the third year where the patients started to regain weight.

Table 3:- Long-term Results of Sleeve Gastrectomy for Obesity by age group

Weight	Age<25 y		Age 25 -34 y		Age 35 -44 y		Age≥45y		p value
	Mean(SD)		Mean(SD)		Mean(SD)		Mean(SD)		
Before surgery	131.17	(31.62)	129.42	(30.28)	114.39	(17.56)	117.25	(19.31)	<0.001
After 3 months	118.20	(29.18)	114.63	(31.83)	102.86	(17.03)	105.76	(17.74)	.003
After 6 months	110.21	(26.90)	98.13	(19.87)	96.59	(15.12)	98.89	(18.15)	.057
After 9 months	101.10	(34.34)	89.11	(16.49)	84.21	(8.62)	89.01	(14.69)	.103
After 12 months	87.89	(27.33)	91.56	(17.34)	79.11	(19.01)	86.14	(12.52)	.309
After 18 months	86.61	(26.80)	90.81	(32.34)	83.16	(13.30)	82.05	(13.05)	.610
After 24 months	83.63	(28.87)	81.33	(14.86)	83.24	(18.36)	82.53	(15.21)	.993
After 30 months	74.53	(12.69)	91.13	(19.16)	72.55	(13.87)	79.93	(12.24)	.022
After 36 months	88.56	(22.70)	79.29	(22.47)	85.05	(23.37)	85.56	(8.91)	.771
After 48 months	91.61	(26.24)	94.32	(38.23)	80.64	(16.89)	89.00	(8.23)	.784
After 60 months	75.31	(13.41)	91.04	(29.22)	72.83	(7.80)	78.98	(20.54)	.352

Table 3 described the Long-term Results of Sleeve Gastrectomy for Obesity by age group and showed that there is no a significant difference in the rate of weight loss among age group all time except before surgery, after 3 months, after 30 months.

Results:-

The total number of subjects who underwent Sleeve Gastrostomy and included in this study was 306, with a mean age of 33 years old, and females were statistically significant older compared to males. The majority of them were females (67.32%), while males represented only 32.68%. The largest proportion (30.07%) of the participants was in the age group of <25 years old, when looking to male participants only the majority (40.00%) of them were in the age group of <25, while a different finding from female gender was observed where 56.00% of females who underwent sleeve gastrectomy were in the age group of 25-34 years old. The mean weight of the participants before surgery was 124.07, and males had statistically significant higher weight compared to females. The mean Body Mass Index (BMI) for the whole studied sample before surgery was 46.49 kg/m 2, and males had a statistically significant higher BMI compared to females (49.77 kg/m 2 and 44.80 kg/m 2 respectively). 10.46% of participants had Diabetes Mellitus (DM) as comorbidity, 9.15% had hypertension and 3.27% had Dyslipidemia, all of these three comorbidities were higher in males compared to females but the difference was not statistically significant. (Table 1)

Table 2 showed the Long-term results of Sleeve Gastrectomy for obesity by gender, and it was found that, overall, there was a continuous decrease in body weight with increasing the time after surgery till 30 months. Postoperatively, the mean weight (kg) after 3 months, 6 months, 9 months, 1 year, 18 months, 2 years, and 30 months for all participants was as following: 110.82, 101.26, 92.32, 85.92, 85.76, 82.91, and 78.53 respectively. There was a significant difference in the rate of weight loss between the two genders in all times except after 18 and 30 months. After the third year from surgery, it was noticed that, for overall and male gender specifically, the weight started to increase. Where, it was found that the mean weight was increased by 32.07 kg in males compared to the mean weight in the period of 30 months after surgery. This weight regain continued in the fourth year after surgery. For females, the results were slightly different. The difference in the rate of weight regain was statistically significant between the two genders. Then the overall results showed that the weight started to decrease in the period of six years after surgery, where the mean weight was 81.31 compared to 89.66 in the period after four years. This was also clearly shown in Figure (1) where weight loss after gastric sleeve surgery was faster during the first year, and then from the second year the rate of weight loss decreased until the third year where the subjects started to regain weight.

Table 3 described the Long-term results of Sleeve Gastrectomy for Obesity by age group and showed that there was no statistically significant difference in the rate of weight loss among age groups in all times except the time before surgery, and the time of three and 30 months after surgery.

Discussion:-

The results of the present study showed that body weight is affected by age and gender. Thus an individual rate of weight loss will depend on factors such as age, gender and the initial weight before surgery. The gender and age differences found in the current study support the findings of several previous studies (Paxton *et al.,* 1994; Rolls et al., 1997; Thompson *et al.,* 1997; Middleman *et al.,* 1998; O'Dea, 1999) (O'Dea,1994; Abraham et al., 2001), that

showed body weight dissatisfaction, weight concerns, attempt to lose or gain weight, attempt to skip meals are more common among females than male. In addition, age also affects body weight, for example during the age of 20 – 30 years old excess weight loss is faster because of minor changes to eating habits and increased activity levels to lose weight (Bosy-Westphal *et al,* 2003). On the contrary, losing weight requires more effort as the individual reaches middle age due to reduction of muscle mass. Although there is no exact mechanism explaining reduction in muscle tissue with age, it seems that wear and tear on the muscles, combined with hormonal changes, may make the body less efficient at replenishing damaged muscle cells (Elia, 1992). Clearly, when muscles cells are diminished, calories expenditure is decreased. However caloric expenditures depend on the metabolic rate. For example during activities metabolic rate is high, hence, the muscles require 60-70% of cardiac output, but at rest the muscles receive only 15% of cardiac output (Linde *et al.*, 1989; McCully KK et al., 1995). At rest, the metabolic organs actually contribute heavily to metabolic rate and use a higher percentage of cardiac output (about 50%). Even bone receives more than 10% cardiac output at rest (Gallagher *et al.*, 1998). Therefore, it is the level and the duration of activities that determine the metabolic rate of muscular metabolic rate. Although representing only about 6% of bodyweight, the metabolic organs contribute much more dramatically to resting energy expenditure than the quantifiably heavier muscle and fat tissue (Elia, 1992). This new concept provides the basis of "specific energy expenditure" which has critical clinical applications, specific to changes in resting energy expenditure inducted by diseases such as cancer, metabolic disease and diabetes, muscle dystrophy, heart diseases, lungs diseases, and spinal deformities.

The results of the present study showed that there were no significant differences among gender in terms of the presence of comorbidity for hypertension, diabetes and dislipdemia in both group being studied. Therefore the observed post-surgery changes in body weight might had been influenced by gender independent of the impact of "specific energy expenditure" to some extent.

It was also observed that the rate of post-surgical weight loss was faster during the first 12 months, as compared to the second 12 months period. These findings can be explained based on the structural remolding of the gastric musculature. These findings were consistent with previously reported findings (Aarts et al., 2011; Benaiges et al., 2012). Clearly the amount of dietary intake induct stretching of the gastric wall which in turn becomes more effective during the second year after more tissue of gastric remodeling had been established. Further similar observations were noted on quarterly basis. The observations of the present study, regarding post-surgical weight loss, were lower than findings reported by others for patients with similar pre surgery BMI (Brethauer et al., 2009). However the observed post-surgical weight reduction of the present study was comparable to the recommended level set by the World Health Organization (WHO,1997).

Conclusions:-

Based on the results of the present study, it can be concluded that prior and post gastric sleeve surgery body weight is influenced by age and gender. As observed (not carefully statistically analyzed), the rate of weight reduction after gastric sleeve surgery is faster during the first 12 months, compared to the second 12 months. As observed, (not carefully statically analyzed) gastric sleeve affected body loss and that can be considered as effective treatment for obesity and obesity related diseases.

Limitations:-

The present study is limited by some patients who did not complete all examinations after surgery and second, patients who did not report their dietary intake and that might had influenced actual energy intake.

Acknowledgement:-

Authorsare grateful to the Directors of Accelerated Medical Solutions and its staff members for the continuous support they provided throughout the preparation of the research.

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