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General Surgery

Evaluation of water tolerance after Laparoscopic Sleeve Gastrectomy

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ABSTRACT

Background: Obesity is a leading cause of death, luckily it is preventable. Surgical Intervention e.g. laparoscopic sleeve gastrectomy (LSG) is a successful method of obesity management. Patients underwent LSG experience post-operative difficulty of water and fluids intake.

Aim of the work: To determine water and juice tolerance following LSG with incidence calculation and comparing this with short-term outcome of LSG regarding excess weight loss and complications.

Patients and methods: This Study includes 20 patients with ages ranges from 18 to 45 years and their Pre-operative BMI ranges from 38 to 65. Patients underwent LSG and were followed up for 3 months. Early and delayed (3 months later) assessment and contrast study (CS) were done. Of those patients 6 underwent upper GI endoscopy to exclude complications.

Results: In early follow up showed 10 patients (50%) became water intolerant while 3 patients (15%) became juice intolerant. After 3 months 6 patients (30%) became water intolerant while 1 patient (5%) became juice intolerant. Comparing early and delayed CS, the esophageal transit results, unlike gastric transit time showed improvement coinciding with the improvement of tolerability among patients. The difference between water and juices CS results was insignificant.

Conclusion: Fair water tolerance is crucial for early safe hospital discharge after LSG. But after LSG, patients' water tolerance, unlike other fluids is significantly affected. This water intolerance improves over time. More studies with larger samples and longer follow up are needed to determine the long-term outcome of fluid tolerance following LSG and its effect on patient's weight loss and quality of life.

Keywords: *Water; Tolerance; Laparoscopic Sleeve Gastrectomy.*

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INTRODUCTION

Obesity is one of the most common life-threatening conditions. It is the new epidemic of the twenty-first century.[1] A comparison of data from 1988–90 with that from 2000–2002 shows that the prevalence of overweight (defined as body mass index, BMI, of 25–29.9 kg/m^2) increased from 46% to 64.5%, and the prevalence of obesity (BMI ⩾ 30kg/m^2) doubled to 30.5%.[2]

Obesity and overweight have many causes, including genetic, metabolic, behavioral and environmental causes. The rapid increase in prevalence suggests that behavioral and environmental influences predominate, rather than biological changes.[3] Obesity is associated with increased mortality and a high burden of comorbidities including diabetes mellitus, hypertension, non-alcoholic fatty liver disease, musculo-skeletal diseases, obstructive sleep apnea syndrome and certain types of cancers.[4.5]

Several procedures are involved in the surgical management of morbid obesity as the field of bariatric surgery has grown remarkably over the past two decades with over 300,000 procedures performed annually and is now the second most common abdominal operation.[6]

According to the International Federation for the Surgery of Obesity and Metabolic Disorders, Laparoscopic sleeve gastrectomy (LSG) was the most commonly performed procedure worldwide in 2014 reaching 45.9% of all bariatric operations, after building on this experience that LSG was both safe and effective.[7] Many surgeons proposed that LSG could be employed as a primary bariatric procedure.[8]

(LSG) has been demonstrated to be effective in weight loss and resolution of comorbidities.[9] The percentage of excess weight loss after LSG reaches 60% to 75% in different studies.[10] Laparoscopic sleeve gasterctomy (LSG) is one of the restrictive bariatric surgeries which often affects food and fluid tolerance and adversely affects the quality of life. Many studies assessed the tolerance of food and its different types but little number of studies assessed the fluid tolerance after LSG especially the water tolerance.[11]

Fluid tolerance especially water is important for safe hospital discharge, weight loss and patient`s life style.[12]

In this study we aim to determine the effect of laparoscopic sleeve gastrectomy on water and juice tolerance with calculation of incidence and to compare this with short term outcome of LSG regarding excess weight loss and complications.

PATIENTS AND METHODS

This prospective study included 20 consecutive patients in Al-Azhar university hospitals who underwent LSG for morbid obesity from Dec 2020 to Jan 2022. The criteria of patients were identical to NIH 1991; patients having a BMI>40 kg/m, or patients having a BMI > 35 kg/m associated with co-morbidity (diabetes mellitus, hypertension, arthritis, or obstructive sleep apnea). We excluded patients younger than 18 years or older than 60 years. Patients with cardiac diseases, hypothyroidism, with history of dysphagia or odynophagia before the operation and who underwent previous upper GIT surgery or intragastric balloon, hiatus hernia surgery were excluded. Female patients who had conception during follow up and patients who suffer post-operative leakage or hemorrhage were also excluded.

All patients fulfilled the pre-operative questionnaire to exclude any dysphagia, heart burn, epigastric tenderness or hiccups after intake of water and different fluids. All candidates received prophylactic dose of anti-coagulant 12 h before surgery. Our candidates underwent general anesthesia, then placed in supine split leg position and the surgeon stands between the patient's legs. A verse needle is then inserted and CO_2 insufflation is induced until reaching 15mmHg then the patient is positioned in reverse Trendelenburg position. Five ports are placed and the liver retractor is inserted through the epigastric port to elevate the left live lobe. Dissection of the greater omentum from the stomach wall is started using ultrasonic dissector on the greater curvature of the stomach and it is continued carefully upward until reaching its end next to the left crus of the diaphragm, then the dissection is completed downward to 2-6 cm from the pylorus of the stomach. Once the greater curvature of the stomach is completely separated from the omentum, 36F bougie is inserted by the anesthetist to pass through the cardia, body and pylorus and it is pushed along the lesser curvature by the surgeon, then we use endoscopic stapler and start stapling the stomach from the pyloric part and continue stapling along the bougie as a calibration tube by using 3 to 4 linear staples with green or blue load until the cardiac end of the stomach. The sleeved stomach is inspected for any hemorrhage or leak after methylene blue test and the suture line hemostasis is established using endo-clips then the resected part of the stomach is removed through the camera port and a drain is inserted along the suture line for post-operative monitoring. The figures below demonstrate the mentioned steps.

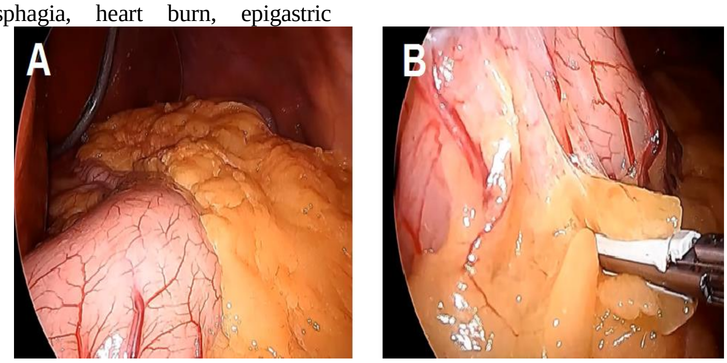

Fig. 1: A: Elevating the liver with retractor and identifying the anterior surface of the stomach. B: Traction of the stomach to make a plane for dissection.

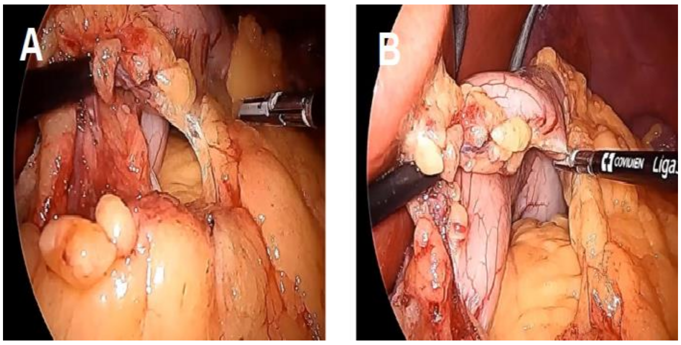

Fig. 2: A: A hole is made exposing the lesser sac of peritoneum. B: Perigastric dissection is conducted upward to the cadria.

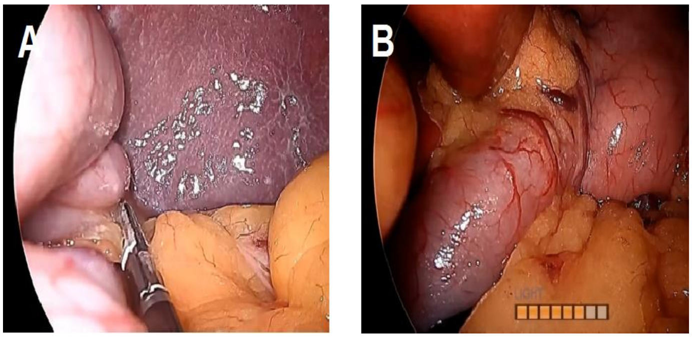

Fig. 3: A: Upward dissection is almost complete reaching the left crus of the diaphragm. B: 36F bougie is passed through the pylorus along the lesser curvature.

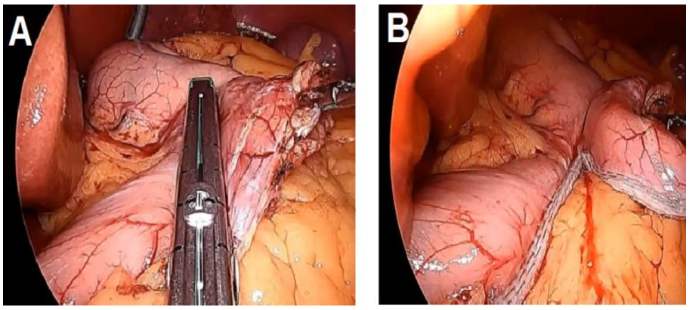

Fig. 4: A: Resection of the stomach is started from the pyloric end 2-6 cm from the pylorus in upward direction using linear staplers. B: After firing the 1st staple dividing the sleeved stomach on the right and the resected stomach on the left.

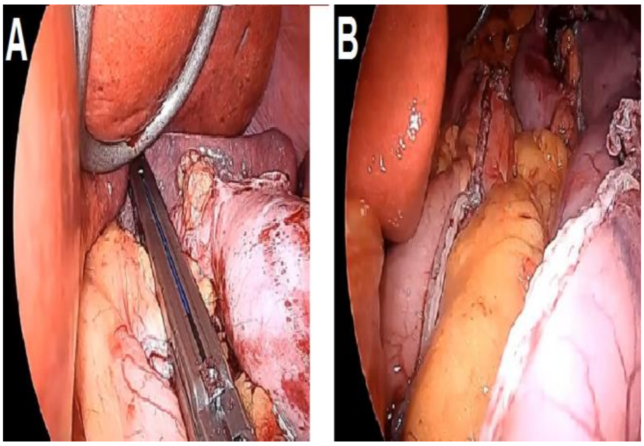

Fig. 5: A: The last stapler is fired to complete the resection cautiously to prevent any injury of adjacent structures e.g. spleen. B: Complete separation was done and the suture line of the sleeve is inspected for hemorrhage or leak.

Post-operative assessment

Patients took oral questionnaire to assess their tolerance to liquids 48hrs and 3 months post-operatively and upon their answers, they were categorized into 4 groups: Group A; Early water intolerant, Group B; Delayed water intolerant, Group C; early juice intolerant and Group D; delayed juice intolerant.

Radio-opaque multi-series meal x-rays were taken twice, the first post- operative DI or D2 and the other one 3 months post-operative, In both series, patients were asked to drink 50 cc of water as well as sugar-free juice, both mixed with 20 ml of radio-opaque contrast.

Water and juice were followed radiologically till passage to the duodenum. Esophageal and gastric transit time were assessed and categorized for both water and juice as "Immediate passage" in which fluid passes smoothly from the esophagus to the stomach (esophageal transit) or from the stomach to the duodenum (gastric transit) without a notable delay (less than 10 sec), (Delay) in which fluid flow shows some delay in the passage process with no more than 20 s and (Hold-up) in which there is more than 20 s delay before any notable passage. The figures below show examples for CS tests.

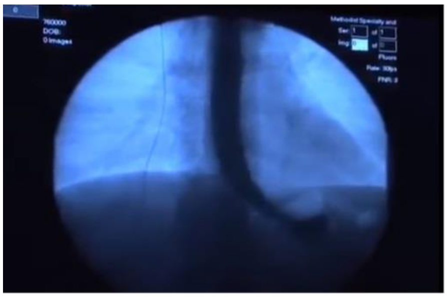

Fig. 6: Gastrograffin swallow study D2 post-operative show immediate passage of water through the LES without notable delay.

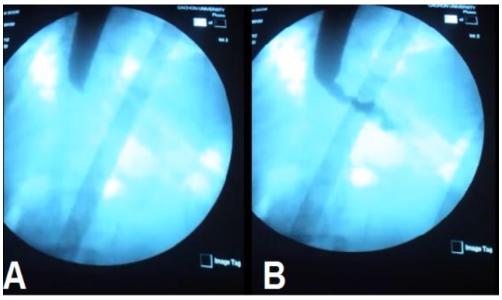

Fig. 2: Gastrograffin swallow study D2 post-operative show delayed passage of juice (B picture taken 15 sec later after A picture).

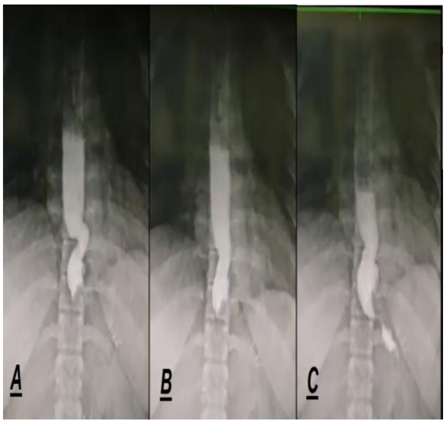

Fig. 8: Gastrograffin swallow for water D90 post-operative show hold up (A picture = immediate after swallow, B picture = 20 sec after swallow, C picture = 27 sec after swallow.

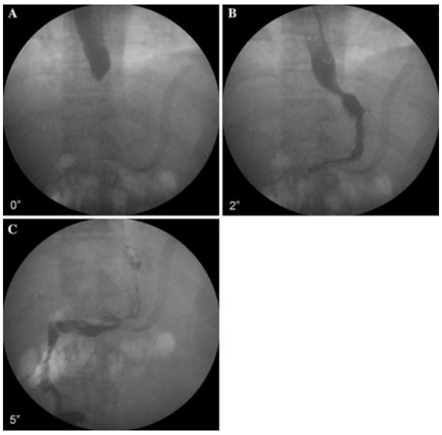

Fig. 9: Gastrograffin meal with water D2 post-operative show fast (immediate) gastric transit for (contrast reach the duodenum after 5 sec from passing the LES).

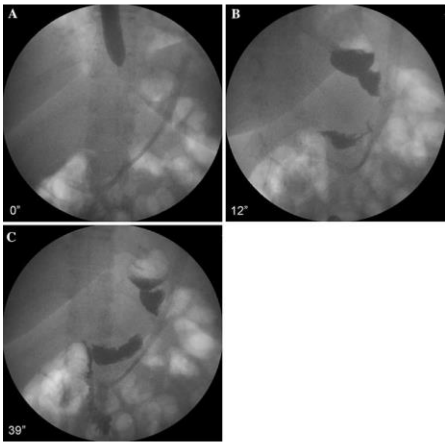

Fig. 103: Gastrograffin meal with juice D2 post-operative slow (hold up) gastric transit = (contrast reaches the duodenum after 39 sec from passing the LES).

Collected subjective tolerance data were compared and correlated with flow pattern of the CS. Percent excess weight loss (%EWL) and complications were also assessed after 3 months. Patients who were intolerable to water after 3 months underwent upper GI endoscopy for possible complications assessment.

RESULTS

		Studied patients (N = 20)	
Age (years)	**Mean ±SD**	30.9 ± 7.1	
	Min - Max	18 – 44	
Weight (kg)	**Mean ±SD**	116.9 ± 17.9	
	Min - Max	92.5 – 166	
Height (m)	**Mean ±SD**	1.59 ± 0.06	
	Min - Max	1.5 – 1.75	
BMI (kg/m²)	**Mean ±SD**	45.9 ± 6.6	
	Min - Max	38.9 – 64.8	
Sex	**Male**	3	15%
	Female	17	85%
Co-morbidities	**Negative**	9	45%
	Positive	11	55%

Table 1: Description of demographic data in all studied patients.

This table shows the description of demographic data in all studied patients. As regard age, the mean age of all studied patients was 30.9 ± 7.1 years with minimum age of 18 years and maximum age of 44 years. As regard weight, the mean weight of all studied patients was 116.9 ± 17.9 kg with minimum weight of 92.5 kg and maximum weight of 166 kg. As regard height, the mean height of all studied patients was 1.59 ± 0.06 m with minimum height of 1.5 m and maximum height of 1.75 m. As regard BMI, the mean BMI of all studied patients was 45.9 ± 6.6 kg/m2 with minimum BMI of 38.9 kg/m2 and maximum BMI of 64.8 kg/m2. As regard sex, there were 3 males (15%) and 17 females (85%) in the studied patients. There were 11 patients (55%) with positive co-morbidities in the studied patients.

Patients were categorized into 4 groups Group A (early water intolerant) included 10 patients (50%) of the sample, group B (delayed water intolerant) included 6 patients (30%), group C (early juice intolerant) included 3 patients (15%) and group D (delayed juice intolerant) was only 1 case (5%).

The number of water intolerant patient decrease after 3 months, decreasing from 10 patients (50%) to only 6 patients (30%) after 3 months, but it is notable that 2 patients of those 6 were tolerant to water at early period

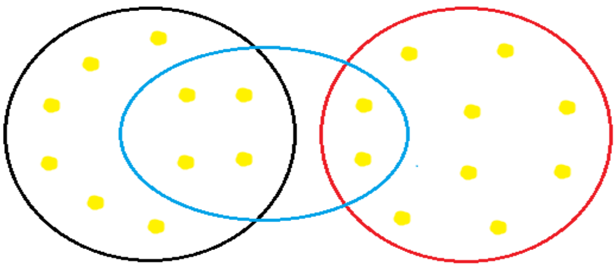

Fig. 11: Black circle: early water intolerant, red circle: early water tolerant, blue circle: delayed water intolerant.

Group B (delayed water intolerant group) underwent upper GI endoscopy to asses any organic cause for delayed water intolerance, the results showed unremarkable findings in 5 of those patients with only one case showing stenotic sleeve segment. 2 (10%) patients of group C (early juice intolerant) improved 3 months later and became tolerant to juice and the third (5%) patient remain intolerant to juice. The mean %EWL (excess weight loss) among early water tolerant patients was 33.6% while it was 30.55% among early water intolerant on the 3-month follow up.

Early contrast study for water and juice flow patterns in the esophagus showed that 14 of 20 patients (70%) had immediate esophageal transit for water and it was 15 (75%)for juice esophageal transit. 4 patients had delayed esophageal transit (10-20 sec) for water while only 3(15%) patients had delayed juice esophageal transit. The early esophageal transit for water was hold up (more than 20 sec) in 2 (10%) patients and it was the same for early esophageal transit for juices.

After 3 months, contrast study for water and juice flow pattern in the esophagus showed that 15 of 20 (75%) patients recorded immediate esophageal passage of water (compared to 14 in the early study) and the other 5 patients (25%) had delayed esophageal transit for water with no incidence of hold up. And for juice contrast study, 17 of 20 (85%) had immediate esophageal transit (compared to 15 on the earlier study) while the other 3 patients (15%) had delayed esophageal transit with no incidence of a hold up

Regarding the early gastric contrast study of the water, 8 patients (40%) were of immediate passage, 7 (35%) were with delayed gastric transit and the other 5 (25%) had a hold up, after repeating to the juice in the early period, 6 patients (30%) had immediate transit of juice through the stomach while 7 patients (35%) had delayed passage and the other 7 patients (35%) had a hold-up.

Delayed contrast study of the stomach after 90 day showed more retardation in the gastric transit of both water and juice, as only 2 patients (10%) had immediate passage of water, 10 patients (50%) had delayed transit and 8 (40%) recorded a hold-up. On the other hand juice gastric transit was immediate in only 1 patient (5%) and delayed in 7 patients (35%) and 12 patients (60%) recorded a hold-up for juice gastric transit.

Day 2		Water (N = 20)		Juice (N = 20)		X^2	P-value
Tolerability	**Tolerable**	10	50%	17	85%	**5.58**	**0.018 S**
	Non-tolerable	10	50%	3	15%		
Esophageal CS	**Immediate**	14	70%	15	75%	0.17	0.915 NS
	Delay	4	20%	3	15%		
	Hold up	2	10%	2	10%		
Gastric CS	**Immediate**	8	40%	6	30%	0.61	0.734 NS
	Delay	7	35%	7	35%		
	Hold up	5	25%	7	35%		

Table 2: Comparison between (water and juice) at day 2 as regard tolerability, esophageal CS and gastric CS. X2: Chi-square test. S: p-value < 0.05 is considered significant. NS: p-value > 0.05 is considered non-significant.

This table shows: statistically significant (p-value<0.05) increased percentage of tolerability to juice (17 patients, 85%) at day 2 when compared with tolerability to water (10 patients, 50%). No statistical significant difference (p-value>0.05) between water and juice as regard esophageal CS and gastric CS at Day 2.

		Day 2 (N = 20)		Day 90 (N = 20)		X^2	P-value
Tolerability to water	**Tolerable**	10	50%	14	70%	1.66	0.197 NS
	Non-tolerable	10	50%	6	30%		
Tolerability to juice	**Tolerable**	17	85%	19	95%	1.11	0.292 NS
	Non-tolerable	3	15%	1	5%		
Esophageal CS (W)	**Immediate**	14	70%	15	75%	2.14	0.342 NS
	Delay	4	20%	5	25%		
	Hold up	2	10%	0	0%		
Esophageal CS (J)	**Immediate**	15	75%	17	85%	2.12	0.346 NS
	Delay	3	15%	3	15%		
	Hold up	2	10%	0	0%		
Gastric CS (W)	**Immediate**	8	40%	2	10%	4.8	0.09 NS
	Delay	7	35%	10	50%		
	Hold up	5	25%	8	40%		
Gastric CS (J)	**Immediate**	6	30%	1	5%	4.88	0.087 NS
	Delay	7	35%	7	35%		
	Hold up	7	35%	12	60%		

Table 3: Comparison between (day 2 and day 90) as regard tolerability, esophageal CS and gastric CS. X2: Chi-square test. NS: p-value > 0.05 is considered non-significant.

This table shows no statistical significant difference (p-value > 0.05) between (day 2 and day 90) as regard tolerability, esophageal CS and gastric CS.

Day 90		Water (N = 20)		Juice (N = 20)		X^2	P-value
Tolerability	**Tolerable**	14	70%	19	95%	**4.32**	**0.037 S**
	Non-tolerable	6	30%	1	5%		

Table 4: Comparison between (water and juice) at day 90 as regard tolerability.

X2: Chi-square test. S: p-value < 0.05 is considered significant.

This table shows statistically significant (p-value < 0.05) increased percentage of tolerability to juice (19 patients, 95%) at day 90 when compared with tolerability to water (14 patients, 70%).

		Day 2 (N = 20)	Day 90 (N = 20)	T	P-value
Weight	**Mean**	116.9	99.8	**3.46**	**0.001 S**
	±SD	17.9	12.9		

Table 5: Comparison between (day 2 and day 90) as regard weight.

T: independent sample T test. S: p-value < 0.05 is considered significant.

This table shows statistically significant (p-value = 0.001) decreased weight at day 90 (99.8 ± 12.9 kg) when compared with weight at day 2 (116.9 ± 17.9 kg).

DISCUSSION

Adequate intake of enough water & fluids after surgeries especially bariatric surgeries is essential to ensure safe patient discharge.[13] Inadequate intake can predispose the patient to hyper-coagulable state which in role may cause venous thrombosis rendering the patient's life to danger. [14]

Also it is suggested that adequate water intake contributes to weight loss by increasing the metabolism pathway in the mitochondria.[15] Decreased hydration of patients may predispose them on the long term to cardiovascular diseases, diabetes and Alzheimer. [16]

In our study the hospital stay was less among water tolerant group [M=2.2 days], while the non-tolerant group stayed much more in the hospital [M=3.4 days].

In clinical practice, many bariatric surgeons noticed that some patient after LSG may have troubles in water intake after the operation & usually the advice them to drink smaller amount of water over longer periods, or substitute water with other low-calorie fluids e.g. sugar-free juices or add some additives to water to make it more compliable.[11]

In last years, many studies were done to assess food tolerance after bariatric surgeries including LSG but there was only small number of studies assessing water and fluid tolerance.[17.18] This study aims to assess water and juice tolerance and to study their esophageal and gastric transit by x-ray studies.

In this study, 50% (10 of 20) of patients experienced early water intolerance typically described as epigastric fullness or stoppage of water for some while, but only 15% (3 of 20) of patients experienced juice intolerance. After 3 months there was a decrease in the number of water-intolerant patients, they were only 6 patients (30%), but it was noticeable that 4 of them had early intolerance and the other 2 had early water tolerance but they developed delayed water intolerance (figure 11). This point gives importance for the long term follow up for SG patients. Also juice tolerance improved among our sample and only 1 patient (previously 3) is still have juice intolerance.

Focusing on the point that good water intake can enhance weight loss and some patients may substitute's water with juice, we found that early water-tolerant group lost 33.6% of EW after 3 months and it was more than the early water-intolerant group as it was 30.5% of EW but this difference wasn't significant.

The improvement for tolerance after 3 months (by subjective questionnaire) was going in-line with the contrast study of the esophagus which also show improvement and decrease in esophageal transit and against the gastric contrast study which showed some worsening and retardation more in the late study than the early one. This makes sense that this short-term improvement may be due the recovery of lower esophageal sphincter (LES) after surgery. But there was no significant difference between the results of CS of esophagus for water and for juice in early or late studies.

In our study we noticed that the water-tolerant group tends to have less gastric transit time [M=10.3 sec] than water-intolerant group [M=19.3]. Another study assessed the gastric (sleeve) transit of water in early phase post-operatively and they reached the hypothesis that the group of rapid gastric transit show better tolerability to water and they can reach the goal of 2L per day hence discharged early from the hospital unlike the group of slow gastric transit, also they followed up the 2 groups for 3 years and noticed that both group lost weight almost equally until 1 year when the delayed-gastric transit scored more weight loss than the rapid-gastric transit group, hence naming the slower-transit dilated sleeve (by contrast study) as efficient sleeve because they tend to lose more weight after 1 year than other patients.[19]

So we can reach the concept that the tolerability of water or other fluids is a complex function starts from the efficiency of LES passing through the sleeve segment reaching the antrum of the stomach until complete gastric emptying happens through the pyloric sphincter. Any obstacle in this pathway may make the patient intolerable.[20]

The intolerance to water that happens after LSG may be due to the following causes: 1- LES dysfunction due to surgery harm or manipulation, this is aided by the fact there is an improvement of esophageal transit after 3 months going on line with the improvement of many patients.[21] 2- Resection of a large portion of the stomach near the greater curvature which contains the pacemaker of the stomach, this may cause increased electrical activity of the stomach and peristaltic movements due to activation of multiple ectopic foci but these movements may be not coordinated thus affecting the smooth complete gastric emptying.[22] 3- Loss of antral motility specially when the resection is generous starting 2-3 cm from the pylorus of the stomach, this is added by other studies which suggest that the increased distance from the pylorus in the resection gives better results in gastric emptying but may be a cause of the failure of the surgery as it may be appoint of distention later on.[23] 4- The endocrinal disturbance after LSG as it is associated with maintained low levels of ghrelin and glucagon like peptide I (GLPI) which have a great impact on the regulation of the gastric emptying.[24]

Previous causes may illustrate the effect of LSG on the tolerance in general but the difference in the tolerance between water and juices may be illustrated from a physical point of view as water is considered a Newtonian fluid (have a constant viscosity regardless the forces applied on it as the temperature is constant), un like juices which are non-Newtonian fluids as there viscosity can change in a response to the applied forces either being thicker (Rheopetics) or thinner (Thixotropic).[25]

So we suggest that although contrast study of water and juices through the esophagus and stomach gave minimal difference which is inconsistent with the significant difference between water and juice tolerance, but these difference can be postulated by how the stomach deal with water and juices not how much they spend until they pass to the duodenum.[26]

This hypothesis is aided by two studies which examined the fluid dynamic inside the stomach reaching that the flow behavior of water and the pressure gradient across the antropyloric portion are different from other fluids of increased viscosity. Water flow is accompanied with strong retropulsive motions with whirlpools formation which are less with other non-Newtonian fluids. Also the pressure gradient was different and it was found that pressure difference within the antropyloric region is directly proportional to the viscosity of the fluid.[27]

All the 6 patients who had water intolerance after 3 months underwent upper GIT endoscopy and only one patient had a short stenotic sleeve segment and this reflect that water and fluid intolerance may be due to an organic complication of surgery.

In our study we had some limitations e.g. small sample size, short term follow-up and the need to study the flow of water and other fluids by dynamic MRI to avoid the effect of the contrast which truly affect the nature of the fluid during the study and give an incomplete picture of 3D motions of stomach during emptying.

CONCLUSION

After LSG, water tolerability unlike other fluids is significantly reduced. Fair water tolerance is crucial for early safe hospital discharge after surgery. This intolerability to water improves over time. More studies with larger samples and longer follow up are needed to determine the long-term outcome of fluid tolerance following LSG and its effect on patient's weight loss and quality of life.

Conflict of interest : none

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