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RESEARCH ARTICLE

EFFICACY OF DUODENAL SWITCH OPERATION IN THE MANAGEMENT OF DIABETES IN MORBIDLY OBESE PATIENTS.

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Abstract

Background: Loop duodenal switch with sleeve gastrectomy is reported to be associated with accepted rates of diabetes remission in obese patients suffering from type II diabetes. We conducted this study to assess the metabolic outcomes of this operation on obese diabetic patients.
Study type: Prospective longitudinal cohort study.
Patients and methods: Twenty-five cases were included in the study with mean BMI of 61.15 kg/m^2. All cases underwent open loop duodenal switch with sleeve gastrectomy. Patients were followed for up after operation for diabetic and metabolic changes.
Results: The mean age of the included cases was 34.16 years. Patient weight and BMI were significantly decreased at follow up ($p < 0.001$). Lipid profile showed a marvelous improvement compared to baseline levels preoperatively. Blood glucose and HbA1c levels were significantly improved ($p < 0.001$). No significant changes were detected regarding bilirubin or calcium levels. Diabetes full remission was detected in 12 cases (48%) and 8 cases (32%) at 1 and 2 years respectively whereas diabetic control was found 4 cases (16%) at the previously mentioned follow up visits. Regarding complications, GERD was detected in 2 cases (8%) while leakage and intestinal obstruction were detected in one case (4%) for each complication.
Conclusion: Based on the results of our study, it is evident that loop duodenal switch with sleeve gastrectomy is effective surgical method in the management of diabetes in obese individuals with accepted morbidity and mortality rates.

Introduction:-

Diabetes mellitus represents a serious medical problem around the globe. Treatment modalities available for type II disease include diet modification, exercise, weight loss, as well as antidiabetic medications. However, adequate disease control is not achieve din many cases via the previously mentioned modalities of management [1].

Multiple reports have stated that obese diabetic patients have achieved good diabetes control or even remission after performing bariatric surgery procedures [2, 3].

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Another review in the literature has concluded that diabetes remission rates may reach 48 – 100% after performing Roux-en-Y gastric bypass in diabetic cases with BMI < 35kg/m^2. The same review also stated that the remission rates may reach 30 – 90% and 47 – 50% for cases with the same BMI range after performing biliopancreatic diversion and sleeve gastrectomy respectively [4, 5].

Metabolic surgery would be an ideal option for diabetic management if they achieved high remission rated without increasing morbidity and mortality rates. The bariatric procedure should have a restrictive as well as a malabsorptive components to achieve better remission rates. Moreover, results would be better if gut hormones homeostasis is modulated. Recently, the two most effective procedures performed for diabetes control are RYGB and biliopancreatic diversion with duodenal switch (BPD/DS). Nevertheless, each of these procedures have its specific short and long term complications [2].

Complications like marginal ulceration, dumping syndrome, as well as bile reflux could be decreased via the concept of pyloric preservation [6].

Sanchez-Pernaute and his colleagues were the first to perform single-anastomosis duodeno-ileal bypass with sleeve gastrectomy. This procedure includes sleeve gastrectomy followed by an anastomosis between proximal duodenal stump and ileal loop about 200 cm proximal to ileocecal valve [7].

With that modification, the occurrence of anastomotic leakage or internal herniation should be decreased as number of anastomoses is decreased without creating mesenteric defects [8, 9].

Furthermore, it provides better glucose homeostasis via foregut hypothesis by exclusion of the second duodenal part [10] and the hindgut hypothesis by jejunal bypass [11].

We conducted this study to assess the metabolic outcomes of loop duodenal switch on obese diabetic patients.

Patients and methods:-

Study design

This a prospective study including obese patients with type II diabetes who presented at Mansoura University Hospital from May 2015 to May 2019. The study was approved by the local ethical committee.

Patient sample

Twenty-five patients (n = 25) with morbid obesity and diabetes and type II diabetes were included in the study. Inclusion criteria included diabetic cases with BMI > 40 kg/m2, failure of medical and conservative treatment modalities for 2 years, age between 12 and 55 years, mentally stable cases, and cooperative and motivated patients.

Patients who were having lack of motivation, mental incompetence, drug addiction, previous bariatric procedures, or generalized severe systemic disease that precludes general anesthesia were excluded from our study. Moreover, non-diabetic cases were also excluded.

Patient consent

A written formal consent was obtained from all cases after the explanation of the details, advantages and drawbacks of the surgical procedure.

Patient preparation

All cases were subjected to complete medical history taking, thorough physical examination, and routine laboratory investigations. Serum cortisol and thyroid profile were also ordered to exclude hormonal disturbances that cause obesity. Additionally, echocardiography, ECG, as well as pulmonary function tests were also ordered. Upper GI endoscopy was performed for all cases to exclude the presence of hiatus hernia or significant reflux disease. Blood glucose level as well as HbA1c were also tested to assess the efficacy of diabetic control before operation.

Preoperative measures

High protein diet was advised for 2 weeks before operation. Subcutaneous enoxaparin was given for all cases 12 hours prior to surgery. Elastic stocking to prevent DVT.

Operative procedure

Two grams of cefazolin was parentrally administered to all patients approximately 30 to 60 minutes before wound incision and another one gram is added every two hours of operation time. Also, 500 mg of metronidazole was given intravenous just before skin incision. Under general anesthesia, all cases were explored via upper midline incision. After division of short gastric vessels, sleeve gastrectomy was performed by staples over 36-F bougie. Furthermore, the entire staple line was oversewn with continuous imbricating sutures.

Duodenum was transected at the level of gastroduodenal artery. And the distal stump was oversewn by absorbable sutures. After identification of ileocecal valve, an end to side hand sewn anastomosis was created between proximal duodenal stump and ileal loop 200 cm proximal to ileocecal valve. Methylene blue test was used to test for anastomotic and staple line leakage.

If the patient had gall stones, cholecystectomy was performed at the same session. Tube drain was inserted near to duodeno-jejunal anastomosis. Finally, abdominal wall was closed in layers.

Post-operative measures

Early ambulation was recommended for all cases. Parenteral proton pump inhibitors were commenced for all cases. Oral gastrograffin test was performed on 5th post-operative day. If no leakage was detected, oral fluid was started. Drain was removed and patients were discharged 6-9 days postoperatively according to postoperative course.

Dietary measures after discharge

Patients continued clear fluids for one week after starting oral intake (sugar free). Then full fluids were allowed during the second week. After that, soft food was started during the third week. Then regular food was started. Oral calcium, multivitamins, and iron were commenced for all patients after discharge.

Follow up

All patients were followed three weeks, three months, eight months, and one year postoperatively then regular visits every six months. Patients were assessed for complications, weight, BMI, and laboratory investigations including CBC, liver and renal function tests, lipid profile, blood glucose levels, calcium, and HbA1c.

Statistical analysis:-

The study was performed at 95% level of significance and power of 80%. The collected data were coded, processed and analysed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (SPSS Inc, Chicago, IL, USA). Qualitative data was presented as number (frequency) and Percent. Paired samples t-test was used to compare patients in the same groups at different time points. $P < 0.05$ was considered to be statistically significant.

Results:-

A total of 25 cases were included in this study. Regarding their demographics, the mean age of the included cases was 34.16 (range, 18-45 years). The majority of the included cases were females (21 cases – 84%) whereas only 4 males were included (16%). The mean preoperative BMI was 61.15 kg/m^2. When it comes the comorbidities, all cases (100%) were having diabetes mellitus while hypertension was present only in 5 cases (20%). Furthermore, obstructive sleep apnea was evident in 2 cases (8%), and arthritis was reported only in one case (4%). These data are shown at table (1).

Table 1:-Demographic data in the study cases.

Items		Study cases n=25
Age (years)	Mean ± SD	34.16 ± 10.02
	Median (min-max)	36 (18-45)
Sex -Male -Female		 4 (16%) 21 (84%)
		61.15 ± 10.21
Comorbidities -Diabetes		 25 (100%)

-HTN	5 (20%)
-OSA	2 (8%)
-Arthritis	1 (4%)

The mean preoperative patient weight was 159.65 kg. After 3 months, there was a marked decrease in the patient weight as it reached 138.85 kg ($p < 0.0001$). The same significance was kept constant when comparing the following follow up visits' readings to the preoperative recordings. Patients weight continued to decrease down to 124.4, 112.75, and 103.63 kg at 8-month, 12-month, and 24-month visits ($p < 0.0001$). These data are shown in table (2) and figure (1).

Table 2:-Follow up of body weight in the study cases.

Time	Study cases n=25
Pre-operative	159.65 ± 25.72
At 3 months	138.85 ± 23.15
P value (in relation to pre-operative value)	**< 0.0001****
At 8 months	124.4 ± 21.44
P value (in relation to pre-operative value)	**< 0.0001****
At 12 months	112.75 ± 20.27
P value (in relation to pre-operative value)	**< 0.0001****
At 2 years	103.63 ± 17.54
P value (in relation to pre-operative value)	**< 0.0001****

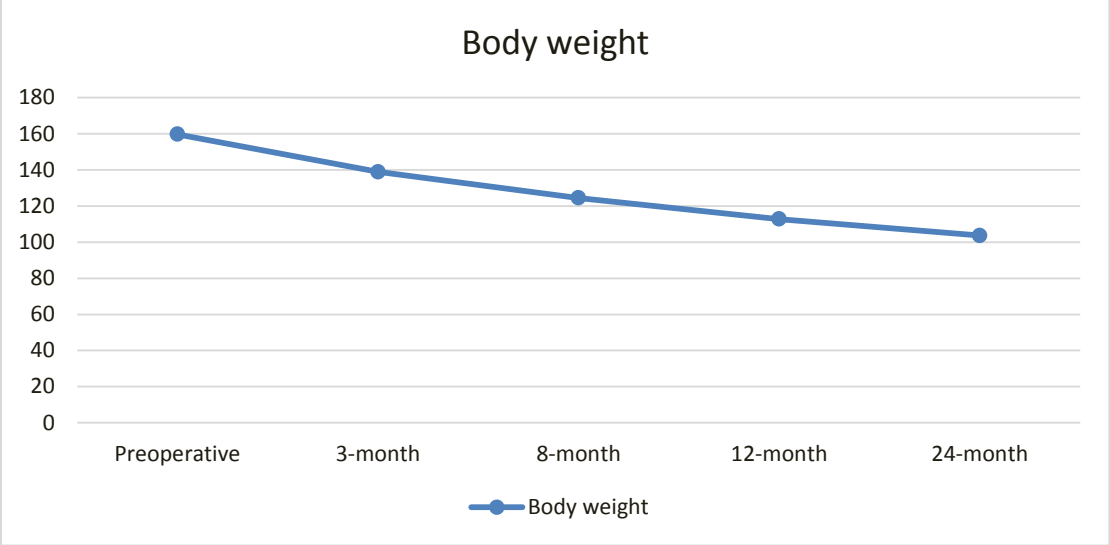

Figure 1:-Changes in body weight after operation.

As there was significant reduction in patients' weight, BMI has also decreased significantly ($p < 0.0001$). The mean value of patients BMI was 53.45 and 47.85 kg/m^2 at 3-montha and 8-month follow up visits. At 2-year visit, BMI has decreased to 32.62 kg/m^2. Thee data are illustrated in table (3) and figure (2).

Table 3:-Follow up of BMI in the study cases.

Time	Study cases n=25
Pre-operative	61.15 ± 10.21
At 3 months	53.45 ± 9.21

P value (in relation to pre-operative value)	< **0.0001****
At 8 months	47.85 ± 8.51
P value (in relation to pre-operative value)	< **0.0001****
At 12 months	43.3 ± 8.21
P value (in relation to pre-operative value)	< **0.0001****
At 2 years	32.62 ± 7.82
P value (in relation to pre-operative value)	< **0.0001****

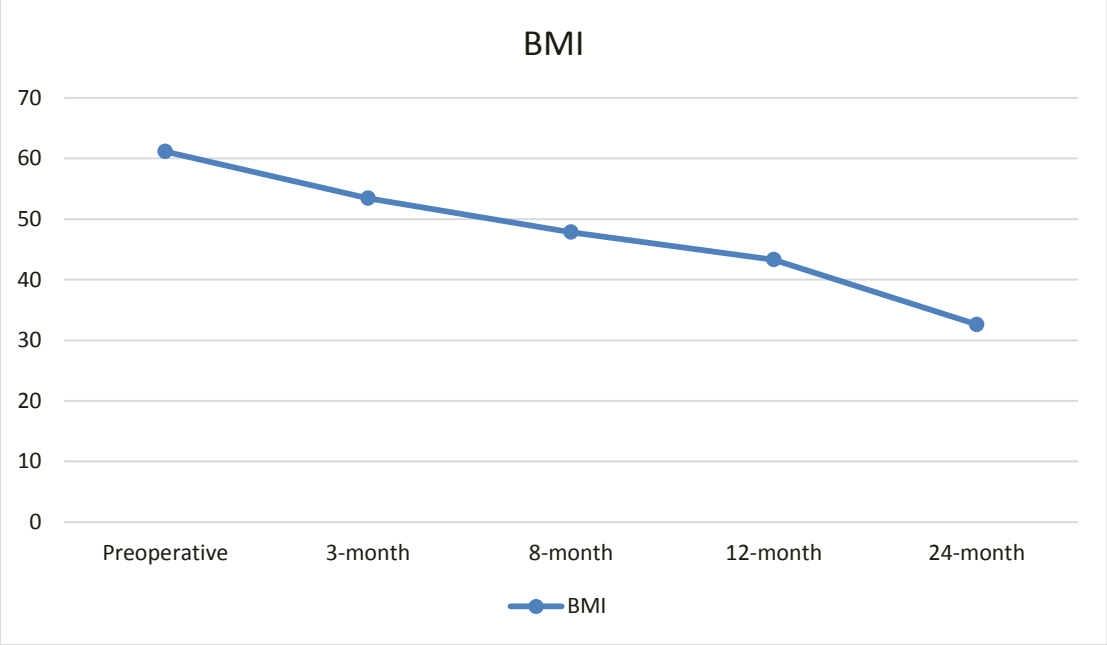

Figure 2:-Changes in BMI after operation.

The preoperative mean level of serum cholesterol was 202.21 mg/dl. At the first follow up visit, it decreased down to 171.71 mg/dl ($p < 0.0001$). On the following visits, there was significant reduction in the cholesterol levels reaching down to 140.05, 123.26, and 104.73 mg/dl at 8-month, 12-month, and 24-month visits respectively. These data are illustrated in table (4).

Table 4:-Follow up of Cholesterol in the study cases.

Time	Study cases n=25
Pre-operative	202.21 ± 31.05
At 3 months	171.71 ± 24.42
P value (in relation to pre-operative value)	< **0.0001****
At 8 months	140.05 ± 20.58
P value (in relation to pre-operative value)	< **0.0001****
At 12 months	123.26 ± 17.83
P value (in relation to pre-operative value)	< **0.0001****
At 2 years	104.73 ± 15.72
P value (in relation to pre-operative value)	< **0.0001****

On the other hand, there was no significant change detected in serum bilirubin levels measured postoperatively when compared to the preoperative levels. These data are shown in table (5).

Table 5:-Follow up of bilirubin in the study cases.

Time	Study cases n=25
Pre-operative	0.75 ± 0.11
At 3 months	0.77 ± 0.14
P value (in relation to pre-operative value)	**0.627**
At 8 months	0.80 ± 0.11
P value (in relation to pre-operative value)	**0.213**
At 12 months	0.78 ± 0.15
P value (in relation to pre-operative value)	**0.489**
At 2 years	0.76 ± 0.18
P value (in relation to pre-operative value)	**0.374**

Like serum bilirubin, serum calcium levels were not significantly different when comparing preoperative levels to the post-operative readings at the scheduled follow up visits. These data are illustrated in table (6).

Table 6:-Follow up of calcium in the study cases.

Time	Study cases n=25
Pre-operative	9.69 ± 0.71
At 3 months	9.59 ± 0.15
P value (in relation to pre-operative value)	**0.527**
At 8 months	9.48 ± 0.52
P value (in relation to pre-operative value)	**0.218**
At 12 months	9.48 ± 0.47
P value (in relation to pre-operative value)	**0.217**
At 2 years	9.55 ± 0.37
P value (in relation to pre-operative value)	**0.429**

At the planned follow up visits, the HDL levels showed a significant increase when compared to the baseline levels preoperatively ($p < 0.0001$). The highest level of HDL measured was at 2-year follow up (62.83 mg/dl). Table (7) illustrates these data.

Table 7:-Follow up of HDL in the study cases.

Time	Study cases n=25
Pre-operative	36.16 ± 7.14
At 3 months	58.3 ± 9.86
P value (in relation to pre-operative value)	**< 0.0001****
At 8 months	55.18 ± 10.74
P value (in relation to pre-operative value)	**< 0.0001****
At 12 months	57.19 ± 6.35
P value (in relation to pre-operative value)	**< 0.0001****
At 2 years	62.83 ± 7.64
P value (in relation to pre-operative value)	**< 0.0001****

Regarding triglycerides, the post-operative readings were all significantly lower than the preoperative levels. However, the 2-year follow up visit readings were relatively of smaller significance ($p = 0.021$) when compared to the previous readings at 8-month and 12-month follow up visits ($p < 0.0001$). Table (8) illustrates these data.

Table 8:-Follow up of TGs in the study cases.

Time	Study cases n=25

Pre-operative	204.16 ± 42.71
At 3 months	184.28 ± 33.18
P value (in relation to pre-operative value)	**0.038****
At 8 months	155.28 ± 29.83
P value (in relation to pre-operative value)	**< 0.0001****
At 12 months	146.28 ± 39.73
P value (in relation to pre-operative value)	**< 0.0001****
At 2 years	176.27 ± 47.27
P value (in relation to pre-operative value)	**0.021****

When it comes to HbA1c, all the readings measured postoperatively at follow up visits were significantly lower than the preoperative levels ($p < 0.0001$). These data are illustrated in table (9) and figure (3).

Table 9:-Follow up of HBA1C in the study cases.

Time	**Study cases n=25**
Pre-operative	9.41 ± 1.73
At 3 months	6.91 ± 1.26
P value (in relation to pre-operative value)	**< 0.0001****
At 8 months	6.42 ± 1.37
P value (in relation to pre-operative value)	**< 0.0001****
At 12 months	7.03 ± 2.11
P value (in relation to pre-operative value)	**< 0.0001****
At 2 years	6.58 ± 1.85
P value (in relation to pre-operative value)	**< 0.0001****

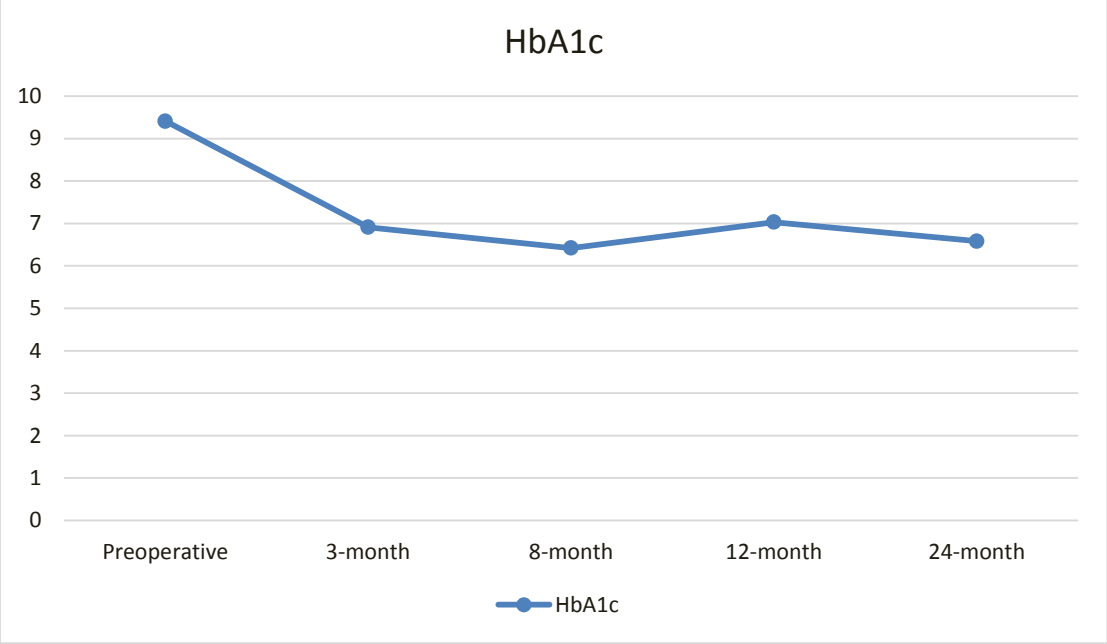

Figure 3:-Changes in HbA1c after operation.

The blood glucose levels showed a significant decrease in the follow up visit readings when compared to the preoperative levels ($p < 0.0001$). Table 10 and figure 4 illustrate these data.

Table 10:-Follow up of blood glucose in the study cases.

Time	Study cases n=25
Pre-operative	235.21± 54.17
At 3 months	165.5±47.8
P value (in relation to pre-operative value)	< **0.0001****
At 8 months	139.6±37.5
P value (in relation to pre-operative value)	< **0.0001****
At 12 months	147.27±41.1
P value (in relation to pre-operative value)	< **0.0001****
At 2 years	153.27 ± 32.62
P value (in relation to pre-operative value)	< **0.0001****

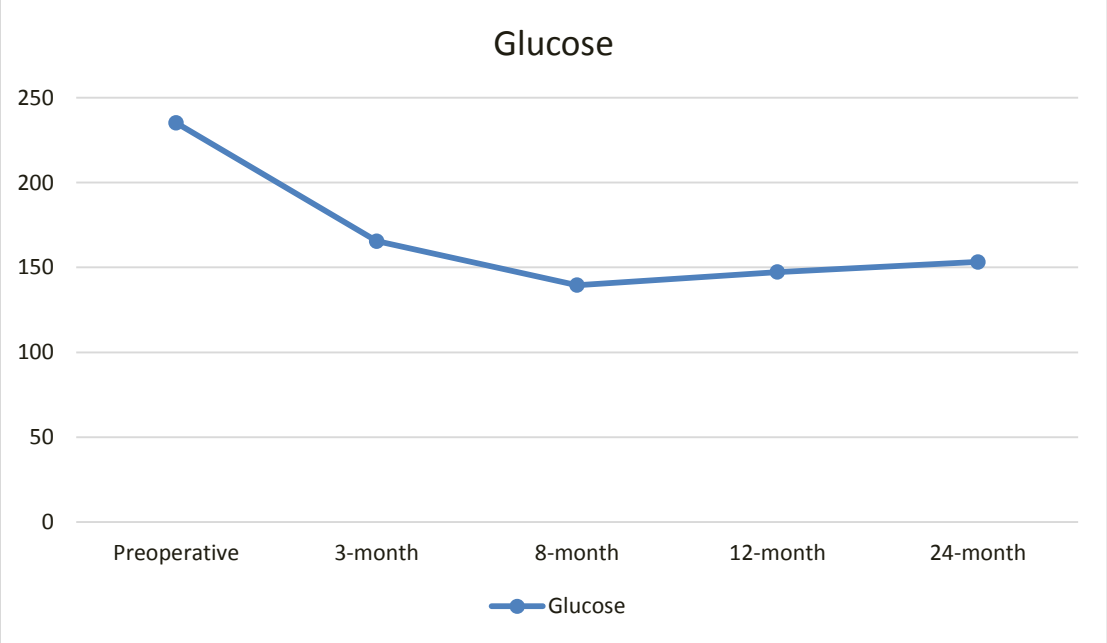

Figure 4:-Changes in blood glucose after operation.

Regarding the incidence of gall stones postoperatively, at 3-month follow up, there was no new cases. At 8-month and 12-month visits, one case and other 2 cases developed gall stones. Moreover, at 2-year follow up, 1 additional case developed gall stones. Table (11) illustrates these data.

Table 11:-Follow up of US findings in the study cases.

Time		Study cases n=25
Pre-operative	Cholecystectomy	3 (12%)
	Gall stones	2 (8%)
At 3 months	Cholecystectomy	5 (20%)
	Gall stones	0 (0%)
At 8 months	Cholecystectomy	5 (20%)
	Gall stones	1 (4%)
At 12 months	Cholecystectomy	6 (24%)
	Gall stones	2 (8%)
At 2 years	Cholecystectomy	8 (32%)
	Gall stones	1 (4%)

As illustrated in table (12) and figure (5), at 1-year follow up visit, twelve cases had full remission of diabetes (48%), whereas diabetes control and improvement were achieved in 4 and 2 cases respectively. On the other hand, failure was encountered in 7 cases (28%).

On 2-year follow up visit, eight cases were still showing full remission (32%) while four cases (16%) showed disease control. The number of cases who showed full improvement increased up to 9 cases (36%). The number of cases with failure decrease down to 4 cases (16%).

Table 12:-Diabetes outcomes in the study cases.

	Diabetes at 1 year	Diabetes at 2 years
Diabetes full remission	12 (48%)	8 (32%)
Diabetes control	4 (16%)	4 (16%)
Diabetes full improvement	2 (8%)	9 (36%)
Diabetes failure	7 (28%)	4 (16%)

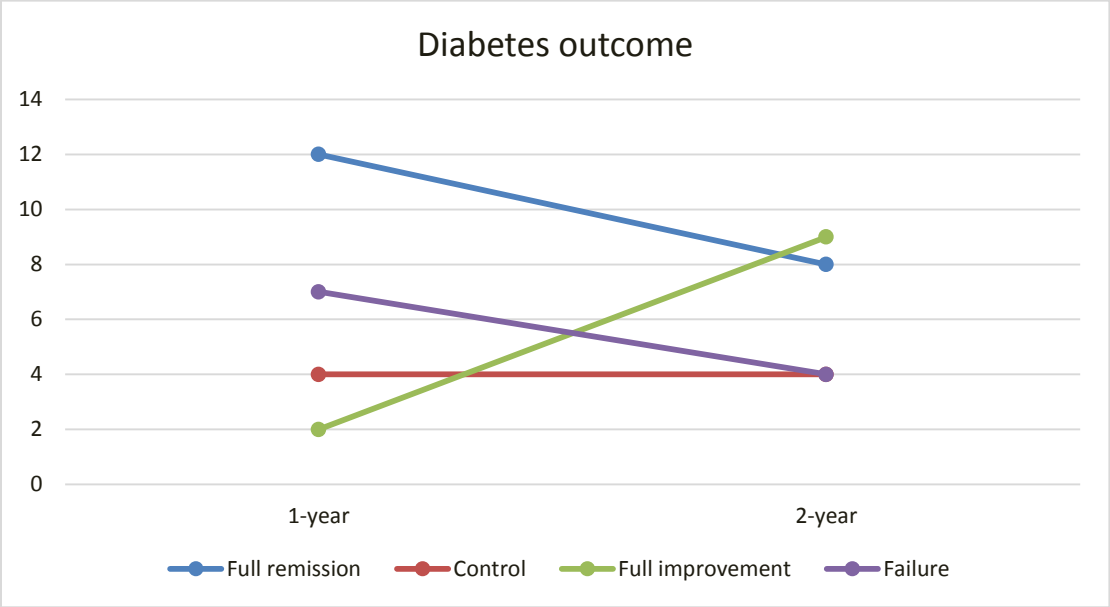

Figure 5:-Diabetes outcome after surgery.

In the early postoperative period, leakage was encountered in 1 case. On the long term, adhesive intestinal obstruction was detected in 1 case while GERD was experienced in 2 cases. These data are shown in table (13) and figure (6).

Table 13:-Postoperative complications.

Complication	Incidence
Leakage	1 (4%)
GERD	2 (8%)
Intestinal obstruction	1 (4%)

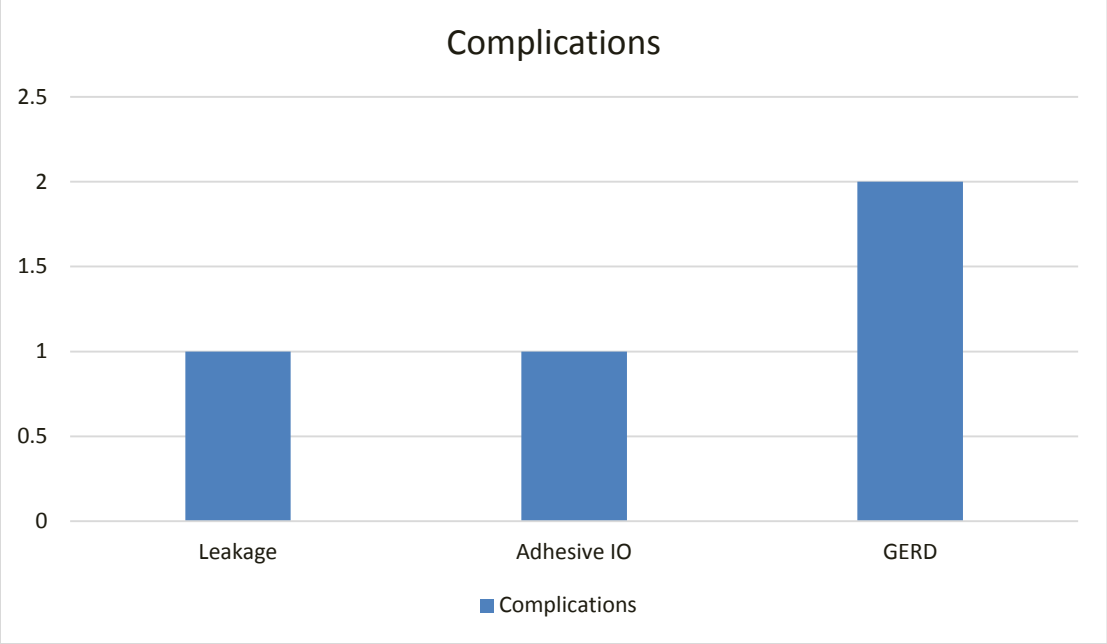

Figure 6:-Post-operative complications

Discussion:-

It has been reported that there is a global rise in the incidence of type II diabetes which leads to an increase in its related morbidity and mortality especially from cardiovascular complications [12].

Type II diabetes is a chronic disease that could be managed by diet modifications, exercise, and medications. However, there is a weak chance of cure. Unfortunately, the results of the previously mentioned modalities are disappointing according to multiple reports in the literature [13, 14].

Conversely, it has been reported that good diabetes remission and control rates could be achieved in obese diabetic patients who underwent bariatric surgery procedures. Although multiple bariatric procedures are existing, better diabetic control was achieved via gastric bypass and biliopancreatic diversion and duodenal switch procedures [15].

This study was conducted at Mansoura University Hospitals aiming to evaluate the effect of loop duodenal switch on diabetes. A total of 25 diabetic patients with mean age of 34.16 years and mean BMI of 61.15 kg/m^2 were included in the study.

Regarding comorbidities other than diabetes expressed in our study patients, 4 cases (16%) was complaining of hypertension while 2 cases (8%) had OSA. Only one case (4%) expresses arthritis at the time of examination.

Obesity itself is considered to be a major cause of morbidity and mortality. Among the well-known complications of severe obesity are increased risks of developing diabetes, hypertension, hyperlipidemia and obstructive sleep apnea. Furthermore, overweight causes excess weight bearing exerted on weight bearing joints leading to degenerative osteoarthritis [16].

Incidence of type II diabetes increases in obese individuals and it is positively correlated with their BMI. Besides, about 25% of hypertension in adults results from excess body weight. Impaired lipid profile is also present in obese individuals, especially persons having central fat distribution [16].

In our study, the mean preoperative patient weight was 159.65 kg. After 3 months, there was a marked decrease in the patient weight as it reached 138.85 kg ($p < 0.0001$). The same significance was kept constant when comparing the following follow up visits' readings to the preoperative recordings. Patients weight continued to decrease down to 124.4, 112.75, and 103.63 kg at 8-month, 12-month, and 24-month visits ($p < 0.0001$).

Consequently, BMI showed comparable results. With a basal BMI of 61.15 kg/m^2, the mean value of patients BMI was 53.45 and 47.85 kg/m^2 at 3-montha and 8-month follow up visits. At 2-year visit, BMI has decreased to 32.62 kg/m^2.

It is thought that super obesity (BMI> 50kg/m2) is the main clinical indication for duodenal switch operation. Nevertheless, this concept cannot be generalized as many of these patients can not adhere to the postoperative instructions. It is also reported that Roux-en-Y gastric bypass is not as effective as DS in that patient group as about 20% of these cases fail to reach the expected weight loss [17]. However, two years after operation, other reports have published similar results between the two procedures (%EWL 72 % and 60 % respectively) [18].

As Ds has a malabsorptive component, late weight regain is also uncommon. A more durable long term result can be obtained by DS [18] with 90 % EWL maintained between 2 - 5 years after the procedure [19].

BPD/DS procedure was found to be superior to all other bariatric procedures as reported by Buchwald's landmark meta-analysis as it achieved 70.1 % excess weight loss, as compared to 61.2 % and 45% for gastric bypass and adjustable gastric banding respectively [20]. Of note, this superiority is more noticed in superobese individuals [21].

Prachand and his colleagues included 350 cases with BMI > 50kg/m^2 in their study conducted to compare between BPD/ DS and RYGB with 3-year follow-up period. A significant decrease in weight and BMI were noticed in BPD/DS when compared to the other group. Additionally, more patients had a BMI < 30 kg/m2 in BPD/DS group at 12 and 18 months. The two groups did not differ significantly regarding post-operative complications and morbidity rates. However, one mortality was reported in the BPD/DS group, but it was statistically insignificant. Hospital stay was significantly loner for DS group compared to the other group [22].

Another prospective randomized study compared the outcomes of BPD/DS and RYGB in the super obese individuals at 1 year follow up. BPD/DS group was associated with significantly much excess BMI loss (75 %) compared to the RYGB group (54 %) ($p< 0.001$). Nevertheless, Ds was associated with longer operative time as well as longer hospital stay. No significant differences were detected regarding complication or morbidity rates. Besides, no mortality was reported in that study [23].

Biertho et al. included 810 obese cases in their series who had DS operation. They had a mean initial BMI of 44.2 ± 3.6 kg/m^2. After 8 year follow up, an EBWL of 76% was reported which denoted that Ds operation can be also performed for non-superobese individuals [24].

Concordantly, Anthone and his colleagues included 701 BPD/DS with BMI ranging between 34 kg/m2 and 95 kg/m^2. EBWL was reported to reach 69%, 73%, and 66% after 1 year, 3 years, and 5 years of follow-up [25]. Overall, multiple series about BPD/DS have reported 61% to 85% EBWL at moderate term follow-up [26].

In addition to marvelous results regarding weight loss, DS patients can also gain a great benefit regarding resolution of obesity related comorbidities like diabetes, hypertension, and sleep apnea. When it comes to diabetes, a 98% diabetes resolution rate was reported in the meta-analysis conducted by Buchwald, compared to 84 % and 48% in RYGB and gastric banding cases respectively [20].

In this study, all HbA1c readings measured postoperatively at follow up visits were significantly lower than the preoperative levels ($p < 0.0001$). Moreover, blood glucose levels showed a significant decrease in the follow up visit readings when compared to the preoperative levels ($p < 0.0001$).

As a result, at 1-year follow up visit, twelve cases had full remission of diabetes (48%), whereas diabetes control and improvement were achieved in 4 and 2 cases respectively. On the other hand, failure was encountered in 7 cases (28%). On 2-year follow up visit, eight cases were still showing full remission (32%) while four cases (16%) showed disease control. The number of cases who showed full improvement increased up to 9 cases (36%). The number of cases with failure decrease down to 4 cases (16%).

The effect of DS operation on diabetes is more noticed in superobese patients. In a previous study, all DS patients were free of their diabetic medications compared to 60% only in the gastric bypass group although diabetic state was more severe in the DS patients [27].

The metabolic benefits of DS operations should be clarified for patients planning to perform bariatric surgery as better diabetic control as well as better lipid profile could be achieved with this procedure when compared to other bariatric procedures [28, 29]. In another practice, no fewer than 90 % of type 2 diabetics were rendered euglycaemic after surgery [19], a finding echoed by others [29, 30].

Dorman and his associates have reported diabetes remission rates of 82% and 64% after DS and RYGB respectively. Moreover, DS cases showed better hypertension control (69% vs. 39 in RYGB), as well as resolution of dyslipidemia (81% vs. 51%) [30]. Another randomized trial reported significantly lower HbA1c levels beside better weight loss at 1 and 3 year follow up in the DS group [31].

The positive effect of DS operation on diabetes starts early after surgery and persists for years. Scopinaro reported that 75% of patients had an FPG <110 mg/dl 1 - 2 months after operation. At 1 year, more than 90% of patients had an FPG <90 mg/dL, and that level was maintained for 10 - 20 years of follow-up [32].

Given the low number of patients who still have diabetes after BPD/DS (<2%), limited conclusions have been made in the literature about predictors of failure with this particular procedure. In a series of patients undergoing GB by Pories, the factors that predicted poor resolution of diabetes were again duration of disease (4.6 vs. 1.6 years, $p<0.04$) and patient age (48.0 vs. 40.7 years, $p<0.01$) [33]. The reason for this phenomenon and the utility of these factors in choosing surgical and nonsurgical strategies remain areas for research [34].

Mingrone et al. conducted a randomized study that included 60 morbidly obese patients with T2DM. They compared the effect of medical therapy (lifestyle modifications and hypoglycemic agents) to surgical intervention (RYGB or BPD). No diabetes remission was reported in the medical group whereas 75% and 95% of cases developed diabetic remission in the RYGB and BPD groups after 2 year follow-up respectively [35].

Supportively, both Iaconelli et al.'s included 50 cases in their uncontrolled series and Tsoli et al.'s included 24 cases in their nonrandomized trial. Both showed resolution of T2DM in all BPD patients 1 year after operation [36, 37]. Another systematic review and metaanalysis confirmed that best diabetes resolution rate can be achieved after Ds, followed by RYGB and gastric banding in order of speech [2].

Astiarraga et al. recently assessed the effect of BPD/DS on T2DM in nonobese patients demonstrating marked amelioration (improved glycemia) of metabolic control and remission (HbA1C <6.5% and normal oral glucose tolerance test) in 1/3 of patients, suggesting a weight independent effect of the operation, as only modest weight loss (-12 kg at 2 months, -14 kg at 1 year) was observed in this nonobese patient population [38].

Other cardiometabolic risk factors, including hypertension and dyslipidemia, have also shown marked improvement following BPD/DS. Additionally, obstructive sleep apnea was resolved in the majority of patients [26].

In our study, the lipid profile of the included cases showed a marvelous improvement when compared to the preoperative values. The preoperative mean level of serum cholesterol was 202.21 mg/dl. At the first follow up visit, it decreased down to 171.71 mg/dl ($p < 0.0001$). On the following visits, there was significant reduction in the cholesterol levels reaching down to 140.05, 123.26, and 104.73 mg/dl at 8-month, 12-month, and 24-month visits respectively.

In addition, at the planned follow up visits, the HDL levels showed a significant increase when compared to the baseline levels preoperatively ($p < 0.0001$). The highest level of HDL measured was at 2-year follow up (62.83 mg/dl). Regarding triglycerides, the post-operative readings were all significantly lower than the preoperative levels. However, the 2-year follow up visit readings were relatively of smaller significance ($p = 0.021$) when compared to the previous readings at 8-month and 12-month follow up visits ($p < 0.0001$).

Regarding post-operative complications, leakage was encountered in 1 case (4%). On the long term, adhesive intestinal obstruction was detected in 1 case (4%) while GERD was experienced in 2 cases (8%).

There is undoubtedly a steep learning curve that surgeons undertaking DS have to negotiate which probably explains the high leak rates reported in some early studies of open and laparoscopic duodenal switches performed 10 or more

years ago (0–6.6 % leak rate), and more recent low volume studies (6.8–8 % leak rate). Higher volume, recent studies consistently report leak rates of 0–3.5 % [39].

In a study of 805 DS patients, Biertho reported a 2.4 % incidence of intestinal obstruction, with 1.6 % requiring further surgery [24], findings that are similar to those reported after RYGB. Intestinal obstruction after laparoscopic DS can result from simple adhesions, port site hernia, incorrect anastomotic technique (twisting or narrowing) or ischemic stenosis. However, the most dangerous causes are internal herniation of the bowel and organo-axial rotation of the very long alimentary limb [40].

In this study, hypocalcemia was not encountered in the patients during the scheduled follow up visits. This can be explained by the strict information given for the patients about the serious effects of missing multivitamin and mineral tablets commenced for them every day.

The main drawback of this study is that included a small sample size (n = 25 cases). Furthermore, the follow up of the cases included short and medium term only. As a result, more studies including larger number of cases with longer follow up periods should be conducted in the future.

Conclusion:-

Based on the results of our study, it is evident that loop duodenal switch with sleeve gastrectomy is effective surgical method in the management of diabetes in obese individuals with accepted morbidity and mortality rates.

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