# Effects of vertical sleeve gastrectomy on serum visfatin level and insulin resistance in obese diabetic and obese nondiabetic cases

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**Introduction**
Visfatin is an adipokine that is highly expressed in visceral fat and has various functions, including activation of insulin receptor and has insulin mimetic effects and improving insulin sensitivity. Laparoscopic sleeve gastrectomy (LSG) is a technically less complex surgical procedure which is promising for the weight loss and treatment of obesity and type 2 diabetes mellitus (T2DM).

**Objectives**
To evaluate serum levels of visfatin before and after sleeve gastrectomy surgery and their relationship with insulin resistance in obese diabetic and obese nondiabetic cases.

**Patients and methods**
This study was conducted on 80 patients with age ranged between 18 and 60 years who underwent LSG in our Bariatric Unit. They were divided into two groups: group 1consisted of 40 nondiabetic patients. Group 2consisted 40 patients who were diagnosed with T2DM of more than 1-year duration.

**Results**
When comparing groups, there is a highly statistical difference ($P \leq 0.001$) as regards: fasting plasma glucose (FPG), homeostatic model assessment of insulin resistance (HOMA-IR), and glycated hemoglobin being higher in group 2. The visfatin level was significantly higher in group 2 ($P \leq 0.05$).

**Conclusion**
Weight reduction after LSG is associated with a significant decrease in visfatin in both morbidly obese patients and patients with obesity and T2DM.

**Keywords:**
obese diabetic cases, obese nondiabetic cases, serum visfatin level, sleeve gastrectomy

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## Introduction

Adipose tissue acts as an endocrine organ producing proinflammatory factors from infiltrating macrophages and/or adipocytes in patients with high BMI, waist circumference (WC), and waist to hip ratio (WHR). These include tumor necrosis factor-alpha, C-reactive protein, interleukin-18, interleukin-6, and visfatin [1]. These cytokines have been linked to impairments in insulin action in the liver, muscle, and adipose tissue, in the form of increase of insulin resistance and impairment of pancreatic islet β-cells which lead to an increased incidence of type 2 diabetes [2].

Visfatin is one of the adipokines which is highly expressed in visceral fat and the blood stream and has various actions, including activation of insulin receptor and has insulin mimetic effects, improving insulin sensitivity and lowering blood glucose level [3]. Most of the literature findings reported that bariatric surgery is an effective treatment for obesity with tendency to rapid weight loss after the surgery, with a negative energy balance in the first few weeks [4,5]. Laparoscopic sleeve gastrectomy (LSG) is a technically less complex surgical procedure with promising literature reports for the treatment of obesity and type 2 diabetes mellitus (T2DM) [6]. Increased plasma visfatin levels after weight loss surgeries indicate a role for visfatin in improved insulin sensitivity [7], yet in 2013 Hosseinzadeh *et al*. [8] reported a decrease in serum visfatin levels after bariatric surgery induced weight reduction with no significant correlation between changes of visfatin, BMI, WC, and insulin resistance and suggested further studies to clarify these associations.

### Objectives

The aim of this study was to clarify the relation between serum levels of visfatin before and after

sleeve gastrectomy surgery and insulin resistance in obese diabetic and obese nondiabetic cases.

## Patients and methods

### Study participants

The current study was conducted on 80 patients with age ranged between 18 and 60 years who underwent LSG in the Bariatric Surgery Department, Ain Shams University Hospital and then reassessed 3 months after the operation ethical approval was obtained from Ain Shams University; Faculty of Medicine. Research Ethics Committee, FWA000017585.

They were divided into two groups: group 1: formed of 40 obese nondiabetic patients with a BMI more than or equal to 35 kg/m$^2$ with comorbidity or more than or equal to 40 kg/m$^2$ with or without other comorbidities. Group 2: formed of 40 obese patients who were diagnosed with T2DM of more than 1-year duration with a BMI of more than or equal to 35 kg/m$^2$with or without other comorbidities.

We excluded from our study patients with psychiatric diseases, T1DM, chronic kidney disease, chronic liver disease, history of hormonal therapy, or medications that may affect insulin sensitivity such as thiazide diuretics, metformin, thiazolidinediones, and cortisol at least for 6 months before the study or other endocrine disorders such as hypothyroidism and Cushing's syndrome and malignancy.

All the patients in our study were submitted to the following:

(1) Informed signed consent to participate in this study.
(2) Full clinical history including name, age, history suggestive of diabetes, and other associated illnesses.
(3) Complete physical examination.
(4) Anthropometric measurements (BMI: weight/height in kg/m$^2$, WC, WHR, and skin fold thickness) before and after sleeve gastrectomy operation.
(5) Data collected from patients who underwent LSG in Bariatric Surgery Department, El Demerdash University Hospital.
(6) Laboratory investigations.

Before sleeve gastrectomy all patients were subjected to the following investigations:

Renal function tests (urea and creatinine), liver function tests (alanine transaminase, aspartate transaminase), serum low-density lipoprotein level, serum high-density lipoprotein level, serum triglyceride level and serum total cholesterol level, complete blood count and coagulation profile [prothrombin time (PT), partial thromboplastin time (PTT), and international normalized ratio (INR)], fasting plasma glucose, glycated hemoglobin (HbA1C), fasting serum insulin by enzyme-linked immunosorbent assay (ELISA), calculation of homeostatic model assessment of insulin resistance (HOMA-IR), serum visfatin level by ELISA, and abdominal ultrasound.

Then patients were subjected to the following investigations 3 months after sleeve gastrectomy:

Fasting plasma glucose, HbA1C, fasting serum insulin by ELISA, calculation of HOMA-IR, serum visfatin level by ELISA.

### Methods

Serum visfatin by ELISA for quantitative assessment based on biotin double-antibody sandwich technology to assay human visfatin by GenAsia Biotech Co. (Philippine Manila UG41, Land Pioneer, 128 Pioneer St., Mandaluyong City) (Catalog No. GA-E0073HM).

### Technique of sleeve gastrectomy

LSG is performed for morbid obesity with the patient in supine position on a split-leg operating table. The surgeon stands between the patient's legs with the first and second assistants on the patient's right and left sides, respectively. Under general anesthesia, the procedure is begun with open entry into the abdomen through an incision 10 cm above the umbilicus. A 12 mm visi-port is placed 10 cm above the umbilicus for camera introduced under direct vision. A 15 mm port is placed for left hand in the right mid-clavicular line. A 12 mm port is placed for right hand in the left mid-clavicular line. Elevation of left lobe of the liver by 5 mm Nathanson retractor [9].

In steep reverse Trendelenburg position, dissection begins with opening of the greater omentum using an ultrasonic dissector or LigaSure along the greater curvature of the stomach ~4 cm proximal to the pylorus. The dissection is continued cephalad to the gastroesophageal junction and the left crus. The short gastric vessels are ligated carefully and care is taken to avoid injury to the spleen [9].

The left crus is completely freed of any attachments to avoid leaving a posterior pouch when constructing the sleeve in this region. The dissection is completed by freeing any posterior attachments of the stomach to the pancreas. This is performed with sharp dissection to avoid thermal injury to the pancreas or the lesser curvature of the stomach [9].

### Statistical analysis

Data were analyzed using PASW predictive analytics software (applied statistical software), Version 18.

Normality testing of continuous data was done with Shapiro–Wilk test; parametric data were presented as mean and SD; and nonparametric data were presented as median and interquartile range.

Categorical data were presented as number and percent of total.

Comparative analysis of continuous data was done with unpaired *t* test or Mann–Whitney test according to data distribution.

Paired data were compared with paired *t* test or Wilcoxon signed rank test according to data distribution.

Comparative analysis of categorical data was done with Fisher's exact test.

Correlations were done with Spearman's correlation coefficient.

Alpha error was set to 5%, and the *P* value was considered significant if it is less than 0.05.

Data were tabulated and graphically represented.

## Results

The study was conducted on 80 patients who underwent a LSG in the Bariatric Surgery Department, Ain Shams University Hospital and then reassessed 3 months after the operation.

Results are presented in Tables 1–5, Fig. 1.

### When comparing the obese nondiabetic group 1 with the obese diabetic group 2

There is a statistically significant difference ($P \leq 0.05$) as regards age with mean 34.03±7.70 and 39.88 ±10.77 years, respectively being higher in group 2, while there were no statistically significant difference ($P > 0.05$) as regards weight with mean 128.23 ±22.42 kg and 132.60±33.26 kg, respectively, height with median 164 (160–168 cm) and 162 cm (160–172 cm), respectively, BMI with mean 46.90±7.10 and 48.26±10.21 kg/m$^2$, respectively, WC with mean 131.00±15.24 and 131.58

**Table 1 Showing comparison between groups as regard baseline demographic and anthropometric data, baseline lipid profile, baseline blood sugar control parameters and baseline Visfatin level**

| | Groups | | *P* value | Sig |
|---|---|---|---|---|
| | Obesity without DM | Obesity with DM | | |
| Age (years) | 34.03±7.70 | 39.88±10.77 | **0.007** | **Sig** |
| Gender | | | | |
| Male | 5 (12.5) | 13 (32.5) | 0.06 | NS |
| Female | 35 (87.5) | 27 (67.5) | | |
| Weight (kg) | 128.23±22.42 | 132.60±33.26 | 0.492 | NS |
| Height (cm) | 164 (160–168) | 162 (160–172) | 0.973 | NS |
| BMI (kg/m$^2$) | 46.90±7.10 | 48.26±10.21 | 0.493 | NS |
| Waist circumference (cm) | 131.00±15.24 | 131.58±17.72 | 0.877 | NS |
| Waist/hip ratio | 0.92±0.09 | 0.92±0.07 | 0.887 | NS |
| Skin fold thickness (cm) | 45.24±4.98 | 43.8±4.44 | 0.181 | NS |
| HDL (mg/dl) | 45.45±9.64 | 46.82±7.55 | 0.480 | NS |
| LDL (mg/dl) | 130.20±37.88 | 134.27±41.30 | 0.647 | NS |
| TGs (mg/dl) | 82.7 (54.1–145.8) | 117.9 (92.8–148.9) | **0.005** | **Sig** |
| TChol (mg/dl) | 196.27±37.48 | 207.03±40.61 | 0.222 | NS |
| Fasting glucose (mg/dl) | 99.05±17.21 | 144.60±35.93 | <0.001 | HS |
| Fasting insulin | 3.4 (2.5–4.5) | 3.4 (2.8–4.3) | **0.021** | **Sig** |
| HOMA-IR | 0.7 (0.53–0.95) | 0.86 (0.75–1.09) | <0.001 | HS |
| HbA1C (%) | 4.8 (4.35–5.11) | 6.45 (5.45–6.85) | <0.001 | HS |
| Visfatin level | 35 (28–41) | 32 (24–35) | **0.019** | **Sig** |

Data are presented as mean±SD, *n* (%), and median (range). DM, diabetes mellitus; HbA1C, glycated hemoglobin; HDL, high-density lipoprotein; HOMA-IR, homeostatic model assessment of insulin resistance; LDL, low-density lipoprotein; Sig, significance; TChol, total cholesterol; TG, triglyceride.

**Table 2 Correlations between baseline visfatin level and other baseline clinical and laboratory parameters in all patients and after subgroup analysis**

| | Visfatin | | | | | |
|---|---|---|---|---|---|---|
| | All patients | | Obesity without DM | | Obesity with DM | |
| | *r* | *P* value | *r* | *P* value | *r* | *P* value |
| Age (years) | 0.064 | 0.573 | 0.185 | 0.254 | 0.115 | 0.480 |
| Weight (kg) | 0.018 | 0.876 | –0.110 | 0.498 | 0.156 | 0.335 |
| Height (cm) | 0.093 | 0.411 | –0.062 | 0.705 | 0.286 | 0.073 |
| BMI (kg/m$^2$) | –0.045 | 0.692 | –0.147 | 0.366 | 0.008 | 0.961 |
| Waist circumference (cm) | 0.066 | 0.561 | –0.003 | 0.986 | 0.095 | 0.561 |
| Waist/hip ratio | 0.020 | 0.859 | 0.038 | 0.816 | 0.063 | 0.699 |
| Skin fold thickness (cm) | 0.122 | 0.282 | 0.19 | 0.24 | –0.067 | 0.683 |
| HDL (mg/dl) | 0.073 | 0.522 | 0.084 | 0.608 | 0.060 | 0.715 |
| LDL (mg/dl) | –0.095 | 0.402 | –0.167 | 0.304 | 0.059 | 0.716 |
| TGs (mg/dl) | –0.176 | 0.118 | –0.071 | 0.661 | –0.204 | 0.207 |
| TChol (mg/dl) | –0.121 | 0.287 | –0.166 | 0.305 | 0.013 | 0.937 |
| Fasting glucose (mg/dl) | –0.190 | 0.092 | –0.071 | 0.666 | 0.222 | 0.168 |
| Fasting insulin | –0.082 | 0.467 | –0.129 | 0.427 | 0.071 | 0.665 |
| HOMA-IR | –0.170 | 0.131 | –0.201 | 0.214 | 0.090 | 0.581 |
| HbA1C (%) | –0.145 | 0.200 | 0.014 | 0.930 | 0.111 | 0.495 |

DM, diabetes mellitus; HbA1C, glycated hemoglobin; HDL, high-density lipoprotein; HOMA-IR, homeostatic model assessment of insulin resistance; LDL, low-density lipoprotein; TChol, total cholesterol; TG, triglyceride.

**Table 3 Comparison of clinical and laboratory parameters before and after operation in subgroups divided by history of diabetes mellitus**

| | Weight (kg) (mean±SD) | BMI (kg/m$^2$) (mean±SD) | Waist circumference (cm) (mean±SD) | Waist/hip ratio (mean±SD) | Skin fold thickness (mean±SD) |
|---|---|---|---|---|---|
| Obesity without DM | | | | | |
| Before | 128±22 | 46.90±7.10 | 131±15 | 0.92±0.09 | 45.23±4.98 |
| After | 104±21 | 38.11±7.08 | 108±14 | 0.83±0.07 | 40.21±5.96 |
| *P* value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Obesity with DM | | | | | |
| Before | 133±33 | 48.26±10.21 | 132±18 | 0.92±0.07 | 43.81±4.44 |
| After | 113±30 | 41.09±9.06 | 118±17 | 0.89±0.08 | 38.9±4.7 |
| *P* value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

| | Fasting glucose | Fasting insulin | HOMA-IR | HbA1C (%) | Visfatin level |
|---|---|---|---|---|---|
| Obesity without DM | | | | | |
| Before | 99±17 | 6.4 (3.8–7.5) | 1.41 (1–1.87) | 5.55 (5.1–6.1) | 50 (42–55) |
| After | 86±10 | 3.4 (2.5–4.5) | 0.7 (0.53–0.95) | 4.8 (4.35–5.11) | 35 (28–41) |
| *P* value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Obesity with DM | | | | | |
| Before | 145±36 | 7.8 (6–8.9) | 2.50 (1.93–2.8) | 8.6 (7–10.1) | 45 (39–50) |
| After | 102±17 | 3.4 (2.8–4.3) | 0.86 (0.75–1.1) | 6.5 (5.5–6.85) | 32 (24–35) |
| *P* value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

DM, diabetes mellitus; HbA1C, glycated hemoglobin; HOMA-IR, homeostatic model assessment of insulin resistance;.

±17.72 cm, respectively, WHR with mean 0.92±0.09 and 0.92±0.07, respectively, skin fold thickness with mean 45.24±4.98 and 43.8±4.44 cm, respectively as shown in Table 1.

### When comparing the obese nondiabetic group 1 with the obese diabetic group 2 as regards baseline lipid profile

There is a statistically significant difference ($P \leq 0.05$) in triglyceride levels between the two groups with a median of 82.7 (54.1–145.8 mg/dl) and 117.9 mg/dl (92.8–148.9 mg/dl), respectively) being higher in group 2, while there was a nonsignificant difference ($P > 0.05$) as regards high-density lipoprotein with mean 45.45±9.64 and 46.82±7.55 mg/dl, respectively, low-density lipoprotein with mean 130.20±37.88 and 134.27±41.30 mg/dl, respectively, and total cholesterol with mean 196.27±37.48 and 207.03±40.61 mg/dl, respectively as shown in Table 1.

**Table 4 Showing comparison between groups as regard degree of change of clinical parameters, degree of change of blood sugar control parameters and degree of change of Visfatin level**

| Degree of change (%) | Groups | | *P* value | Sig |
|---|---|---|---|---|
| | Obesity without DM | Obesity with DM | | |
| Weight (kg) | −19.4±5.1 | −14.98±2.7 | <0.001 | HS |
| BMI (kg/m$^2$) | −19±5.52 | −15±2.64 | <0.001 | HS |
| Waist circumference (cm) | −16 (−19.6 to −14.1) | −11 (−13.5 to −10) | <0.001 | HS |
| Waist/hip ratio | −9.5 (−12.1 to −6.3) | −3.4 (−4.5 to −2.2) | <0.001 | HS |
| Skin fold thickness (cm) | −11.4±5.76 | −11.27±4.76 | 0.917 | NS |
| Fasting glucose (mg/dl) | −11.56±10.38 | −27.47±12.67 | <0.001 | HS |
| HbA1C (%) | −14±6.87 | −24.73±11.2 | <0.001 | HS |
| Fasting insulin | −40 (−49.4 to −30.5) | −52.5 (−56.4 to −41.8) | <0.001 | HS |
| HOMA-IR | −49 (−54.21 to −39.7) | −66.6 (−68.6 to −55.7) | <0.001 | HS |
| Visfatin level | −26.9±16.23 | −35±11.8 | **0.013** | **Sig** |

Data are presented as mean±SD and median (range). DM, diabetes mellitus; HbA1C, glycated hemoglobin; HOMA-IR, homeostatic model assessment of insulin resistance; Sig, significance.

**Table 5 Correlations between percent of visfatin reduction from baseline and percent reduction of other clinical and laboratory parameters**

| | Visfatin reduction (%) | | | | | |
|---|---|---|---|---|---|---|
| | All patients (80) | | No DM (40) | | DM (40) | |
| | *r* | *P* value | *r* | *P* value | *r* | *P* value |
| Weight reduction (%) | −0.162 | 0.150 | −0.23 | 0.153 | 0.243 | 0.131 |
| BMI reduction (%) | −0.156 | 0.166 | −0.200 | 0.216 | 0.237 | 0.141 |
| WC reduction (%) | −0.118 | 0.297 | −0.001 | 0.995 | 0.202 | 0.212 |
| WHR reduction (%) | −0.158 | 0.161 | −0.015 | 0.927 | 0.183 | 0.257 |
| Skin fold thickness reduction (%) | 0.044 | 0.698 | 0.03 | 0.856 | 0.126 | 0.439 |
| FBS reduction (%) | 0.282 | **0.011** | 0.238 | 0.139 | −0.011 | 0.947 |
| Fasting insulin reduction (%) | 0.040 | 0.727 | 0.012 | 0.942 | −0.047 | 0.772 |
| HOMA-IR reduction (%) | 0.141 | 0.212 | 0.147 | 0.366 | −0.042 | 0.795 |
| HbA1C reduction (%) | 0.211 | 0.061 | −0.076 | 0.640 | 0.076 | 0.640 |

DM, diabetes mellitus; HbA1C, glycated hemoglobin; HOMA-IR, homeostatic model assessment of insulin resistance; WC, waist circumference; WHR, waist to hip ratio.

When comparing the obese nondiabetic group 1 with the obese diabetic group 2 as regards baseline blood sugar control parameters:

There is a highly significant difference ($P \leq 0.001$) as regards: fasting plasma glucose (FPG) with mean 99.05 ±17.21 and 144.60±35.93 mg/dl, respectively being higher in group 2; HOMA-IR with median 0.7 (0.53–0.95) and 0.86 (0.75–1.09), respectively being higher in group 2; HbA1C with median 4.8 (4.35–5.11%) and 6.45% (5.45–6.85%), respectively being higher in group 2. Also there is a statistically significant difference ($P \leq 0.05$) as regards fasting insulin with median 3.4 (2.5–4.5 μIU/ml) and 3.4 μIU/ml (2.8–4.3 μIU/ml), respectively being higher in group 2 as shown in Table 1.

When comparing group 1 with group 2 as regards baseline visfatin there is statistical difference ($P \leq 0.05$) with median 35 (28–41 ng/ml) and 32 ng/ml (24–35 ng/ml), respectively being higher in group 1 as shown in Table 1.

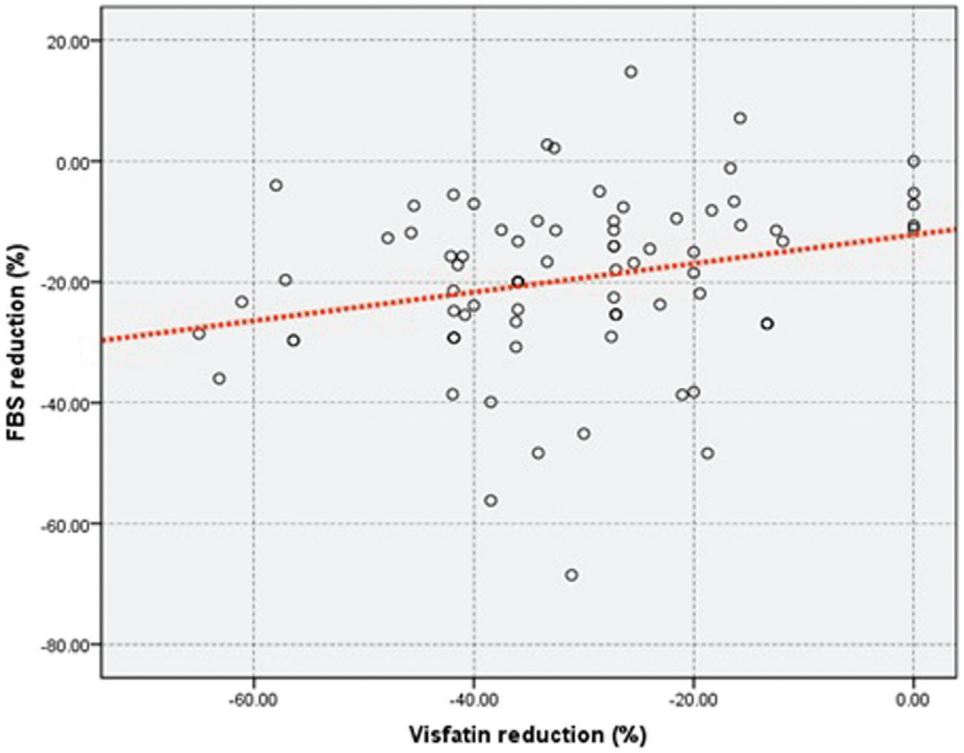
There is no significant correlation ($P > 0.05$) between baseline visfatin level and other baseline clinical and laboratory parameters in all patients and in each 'obesity without DM' group 1 and 'obesity with DM' group 2 as shown in Table 2.

On comparison of clinical parameters before and after operation in groups 1 and group 2:

There is a highly statistically significant difference ($P \leq 0.001$) in 'obesity without DM' group 1 as regards:

Weight with mean 128±22 and 104±21 kg, respectively being higher before operation, BMI with mean 46.90 ±7.10 and 38.11±7.08 kg/m$^2$, respectively being higher before operation, WC with mean 131±15 and 108 ±14 cm, respectively being higher before operation, WHR with mean 0.92±0.09 and 0.83±0.07, respectively being higher before operation, skin fold thickness with mean 45.23±4.98 and 40.21±5.96 cm, respectively being higher before operation as shown in Table 3.

**Figure 1**




Scatter plot showing correlation between visfatin level reduction ratio and fasting blood sugar reduction ratio in all patients.

There is a highly statistically significant difference ($P \leq 0.001$) in 'obesity with DM' group 2 as regards:

Weight with mean 133±33 and 113±30 kg, respectively being higher before operation, BMI with mean 48.26 ±10.21 and 41.0 9±9.06 kg/m$^2$, respectively being higher before operation, WC with mean 132±18 and 118±17 cm, respectively being higher before operation, WHR with mean 0.92±0.07 and 0.89±0.08, respectively being higher before operation, skin fold thickness with mean 43.81±4.44 and 38.9±4.7 cm, respectively being higher before operation as shown in Table 3.

On the other hand, comparison of laboratory parameters before and after operation in groups 1 and group 2 showed the following.

There is a highly statistically significant difference ($P \leq 0.001$) in 'obesity without DM' group 1 as regards:

FPG with mean 99±17 and 86±10 mg/dl, respectively being higher before operation; fasting insulin with median 6.4 (3.8–7.5 μIU/ml) and 3.4 μIU/ml (2.5–4.5 μIU/ml), respectively being higher before operation; HOMA-IR with median 1.41 (1–1.87) and 0.7 (0.53–0.95), respectively being higher before operation; HbA1C with median 5.55 (5.1–6.1%) and 4.8 (4.35–5.11%), respectively being higher before operation; visfatin level with median 50 (42–55 ng/ml) and 35 (28–41 ng/ml), respectively being higher before operation as shown in Table 3.

There is a highly statistically significant difference ($P \leq 0.001$) in 'obesity with DM' group 2 as regards:

FPG with mean 145±36 and 102±17 mg/dl, respectively being higher before operation; fasting insulin with median 7.8 (6–8.9 μIU/ml) and 3.4 μIU/ml (2.8–4.3 μIU/ml, respectively being higher before operation; HOMA-IR with median 2.50 (1.93–2.8) and 0.86 (0.75–1.1), respectively being higher before operation; HbA1C with median 8.6 (7–10.1%) and 6.5 (5.5–6.85%), respectively being higher before operation; visfatin level with median 45 (39–50 ng/ml) and 32 ng/ml (24–35 ng/ml), respectively being higher before operation as shown in Table 3.

**When comparing group 1 with group 2 as regards the degree of change of clinical parameters**

There is a highly statistically significant difference ($P \leq 0.001$) as regards:

Weight with mean −19.4±5.1 and −14.98±2.7 kg, respectively being higher in group 1; BMI with mean −19±5.52 and −15±2.64 kg/m$^2$, respectively

being higher in group 1, WC with median −16 (−19.6 to −14.1 cm, −11 cm (−13.5 to −10 cm), respectively being higher in group 1, WHR with mean −9.5 (−12.1 to −6.3) and −3.4 (−4.5 to −2.2), respectively being higher in group 1, while there were a statistically nonsignificant difference ($P>0.05$) as regards skin fold thickness with mean −11.4±5.76 and −11.27 ±4.76 cm, respectively as shown in Table 4.

#### When comparing group 1 with group 2 as regards the degree of change of blood sugar control parameters

There is a highly statistically significant difference ($P\leq0.001$) as regards: FPG with mean −11.56±10.38 and −27.47±12.67 mg/dl, respectively being higher in group 2; HOMA-IR with median −49 (−54.21 to −39.7),−66.6 (−68.6 to −55.7), respectively being higher in group 2; HbA1C with mean −14±6.87and −24.73±11.2%, respectively being higher in group 2; fasting insulin with median −40 (−49.4 to −30.5 μIU/ml) and −52.5 μIU/ml (−56.4- −41.8 μIU/ml), respectively) being higher in group 2 as shown in Table 4.

When comparing group 1 with group 2 as regards the degree of change of visfatin level there is statistical difference ($P\leq0.05$) with mean −26.9±16.23 and −35 ±11.8 ng/ml, respectively being higher in group 2 as shown in Table 4.

In our study there is a statistically significant direct correlation between percent reduction of visfatin level and percent reduction of fasting blood sugar in all patients ($P\leq0.05$); as regards the rest of parameters no statistically significant relations were found ($P>0.05$) as shown in Table 5 and Fig. 1.

## Discussion

Visfatin has been named and identified as an adiponectin because of its much greater expression in visceral fat than in SC adipose tissue [10]. Safety and effectiveness are required for the successful management of obesity. Sleeve gastrectomy as a bariatric surgery has been shown to be very successful as a long-term treatment that resist the compensatory mechanisms of the body to desire to store food [11].

Sleeve gastrectomy with its notable improvement in weight loss and metabolic parameters act as a happy medium between laparoscopic gastric band (LAGB) and Roux en Y gastric bypass (RYGB). It is technically easier and more safe than the RYGB with the advantages of less nutritional deficiencies due to the maintenance of intestinal continuity with acceptable incidence of mortality and morbidity [12].

The study was conducted on 80 patients who underwent LSG in the Bariatric Surgery Department, Ain Shams University Hospital and then reassessed 3 months after the operation. Patients were included if they had a BMI of more than or equal to 35 kg/m$^2$ with comorbidity or BMI more than or equal to 40 kg/m$^2$ with or without comorbidity.

They were divided into two groups, group 1constituted of 40 obese nondiabetic patients and group 2 was formed of 40 obese patients who were diagnosed with T2DM of more than 1-year duration. The comparison between groups as regards baseline visfatin level found that there was a statistically significant difference between 'obesity without DM' group 1 versus 'obesity with DM' group 2 being higher in group 1 ($P$=0.019).

The high level of visfatin in obese patients without a previous diagnosis of abnormal glucose metabolism compared with the controlled group has been reported by Kaminska *et al.* [13]. On the other hand, some studies have shown that obese patients have a significant lower level of visfatin than people with normal BMI [14,15].

In agreement with our results Toruner *et al.* [16] have shown that visfatin level had significantly decreased in type 1 diabetic patients compared with healthy controls but in disagreement with our data he demonstrated significant correlation between HbA1C and visfatin levels and explain the discrepancy due to different study populations as diabetic patients in their study are younger and had shorter duration of diabetes and higher HbA1C levels than the other study groups; also their patients were uncomplicated diabetics.

The impairment of visfatin signaling, dysregulation in biosynthesis or response to hyperglycemia was the explanation of Chen *et al.* [17] for the higher visfatin level in T2DM patients.

Visfatin has been considered as a new proinflammatory adipokine. Since the main site of visfatin secretion is VAT, it was suggested that its plasma level is related to the visceral obesity and the debates on whether serum visfatin levels, increase or decrease in obese patients could be explained by a more complex relationship between visfatin and body fat level and its distribution; homeostasis of the glucose and other factors such as the

iron metabolism [18], vascular endothelial function [19], genetic and race variation [20], pattern of macronutrient intake, and dietary restriction of adipokine response may also affect visfatin metabolism [21]. The usage of C-terminal assays for detection of visfatin in some studies which was not reliable may be another reason for the discrepancy in these results [22].

In the present study no correlation was found between baseline visfatin level and other clinical and laboratory parameters in all patients, 'obesity without DM' group 1 and 'obesity with DM' group 2.

In agreement with our data, Hosseinzadeh and colleagues could not find any significant association between changes of visfatin levels and changes of blood glucose or HOMA-IR. These findings may be explained by the small sample size and the normal fasting blood glucose before surgery. With a normal range of blood glucose, the need for increased visfatin as a compensatory mechanism to overcome hyperglycemia may be decreased. The high preoperative level of visfatin may be due to the high fat mass rather than of a compensatory mechanism. Also, the normal level of fasting blood glucose may be due to increased visfatin levels to mimic the insulin action. All these theories could explain the absence of correlation between the changes of adipokines, like visfatin and those of blood glucose and insulin sensitivity [8].

In the current study, the fasting insulin level was within normal range in both obese without diabetes group 1 and obese with diabetes group 2 making these patients referred to as insulin sensitive individuals as shown by normal WHR as adiposity is generally distributed and not centralized to the midsection. These patients show glucose disposal either in the adipose tissue or muscle and lack of the liver conversion of glucose to triglycerides [23]. Also, Takebayashi *et al.* [19] reported that pioglitazone thereby for 12 weeks did not affect the plasma visfatin level in diabetic patients.

Yet Chang and colleagues found in their meta-analysis study that plasma visfatin is significantly higher in overweight/obese type 2 diabetic patients. Furthermore, the results indicate that plasma visfatin is related to insulin resistance. Also, their meta-analysis confirmed an interaction between visfatin and glucose homeostasis, and suggests that this theory is not prejudiced by the extent of overweight/obesity [24].

In the López-Bermejo and colleagues study, patients with long-standing T2DM had higher visfatin levels than the nondiabetics. Visfatin levels increased with progressive pancreatic beta-cell dysfunction suggesting that the increase in the level of visfatin acts as a compensatory mechanism in patients with longer standing T2DM [25].

Chen and colleagues found that the plasma visfatin level is significantly associated with WHR and did not correlate with BMI. This fact is consistent with findings that the pathogenetic mechanism of visfatin in T2DM is different from that of insulin resistance and visfatin is mainly secreted in visceral fat, not SC fat [17]. Haider *et al.* [26] reported that plasma visfatin level significantly correlated male WHR and BMI but not in female diabetic patients.

In this study, there was a statistically significant direct correlation between percent reduction of visfatin level and percent reduction of fasting blood sugar in all patients ($P<0.011$) while as regards the rest of parameters no statistically significant relations were found.

The Liang *et al.* [27] study reports are comparable to our findings of the positive correlation between serum visfatin level and fasting glucose level in gestational DM. Also the findings of Chen *et al.* [17] study demonstrated that plasma visfatin was associated with age, WHR, fasting insulin, and HOMA-IR in simple regression analysis, but in the multiple regression analysis only plasma visfatin level remained positively associated with WHR. However, in the study by Berndt and colleagues, there was a significant correlation between visfatin plasma concentrations and the obesity measurements such as BMI and body fat content but not with WC or WHR. At the same time, they reported a significant positive relationship between BMI, WC, percent of body fat, and visceral visfatin expression but no similar relationship exists for subcutaneous visfatin gene expression [28].

Also, there was highly statistically significant difference as regards fasting glucose level, fasting insulin level, HOMA-IR, HbA1C (%), and visfatin level being higher before operation ($P<0.001$).In agreement with our present results, some studies have found decreased levels of circulating visfatin after sleeve gastrectomy [26,29] . The reduction of visfatin concentration after bariatric surgery come in accordance with the theory that visfatin is overproduced in obesity possibly to compensate insulin resistance caused by increased adipose tissue; following weight loss the need for this mechanism

would be decreased [29,30]. However, some reported increased plasma visfatin levels after the operation [30–32].

Moreover, some studies could not find any significant postoperative changes of visfatin levels [33]. In the same manner, DeLuis *et al.* [32] reported that visfatin concentrations did not change after 1 year of surgically induced weight reduction.

In comparing the two groups of the current series, BMI, WC, and WHR were significantly higher in group 1 ($P<0.001$) but there was statistically nonsignificant difference as regards skin fold thickness. The fasting blood glucose level, fasting insulin level, HOMA-IR, and HbA1C (%) changes were significantly higher in group 2($P<0.001$). The change of visfatin level before and after operation was significantly higher in group 2 ($P<0.013$). These results support the success of sleeve gastrectomy surgery in achieving and maintaining profound weight loss for both 'obesity without DM' group 1 and 'obesity with DM' group 2.

Tamara [34] confirmed rapid and durable weight loss as characterized by percentage excess body weight lost at 3 and 6 months' postsleeve gastrectomy surgery. Also Shi *et al.* [35] in obesity surgery 2010 demonstrated excess body weight loss of 35% at 6 months.

Also, our results have shown that sleeve gastrectomy operation increased remission of obesity-related comorbidities, such as T2DM confirmed by a reduction in blood sugar control parameters. These results are consistent with the study which found that surgery results in greater improvement in weight loss outcomes and weight-associated comorbidities compared with nonsurgical interventions, regardless of the type of procedures used [36].

Another study by Nocca and colleagues demonstrated a reduction in usage of pharmacological therapy and decrease in HbA1C with remission of T2DM in 60% of the LGBP group and 75.8% of the LSG group at 1-year postoperative follow-up and concluded that LSG seems to be as effective as LGBP for the management of T2DM in severely obese patients [37].

In agreement with our results another study of 64 T2DM patients with an HbA1C of more than or equal to 7.0% were randomly assigned to receive LSG or RYGB procedure, after a 36-month follow-up both groups had similar baseline anthropometric measures. Complete remission (HbA1C <6% for 1 year without antidiabetic medications) was achieved by 78.6% of sleeve gastrectomy (SG) group and 85.2% of RYGB group. This could approve that the SG had similar positive effects on diabetes and dyslipidemia compared with RYGB in T2DM patients.

## Conclusion

Weight reduction after bariatric surgery is associated with a significant decrease in circulating concentrations of the adipokine visfatin in both morbidly obese patients and patients with obesity and T2DM. There is a statistically positive correlation between visfatin level reduction ratio and fasting blood sugar reduction ratio in all patients which shows that visfatin may play a role in glucose homeostasis.

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### Conflicts of interest

There are no conflicts of interest.

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