Egypt, J. Plast. Reconstr. Surg., Vol. 47, No. 3, July: 207-212, 2023

The Effect of Abdominal Contouring on Metabolic Syndrome and Insulin Resistance

ABRAHAM H. SHAWKY, M.B.B.Ch.*; NESMA H. AHMED, M.D.**; AHMED M. ABDELSALAM, M.D.*; SALAH N. MOHAMMED, M.D.* and MOHAMED S. BADAWY, M.D.*

The Departments of Plastic, Reconstructive & Maxillofacial Surgery and Internal Medicine, Endocrinology & Metabolism**, Faculty of Medicine, Ain Shams University*

ABSTRACT

Background: The deep layers of abdominal subcutaneous adipose tissue (SAT) behave functionally like the visceral adipose tissue (VAT). Both aggravate insulin resistance and affect the metabolic profile in a similar manner. So, the removal of Abdominal subcutaneous tissue in abdominal contouring surgeries as liposuction and lipo-abdominoplasty can positively affect insulin resistance and the metabolic profile.

Objective: To assess the effect of abdominal contouring on metabolic syndrome and insulin resistance.

Patients and Methods: 50 female patients with localized abdominal obesity i.e. skin pinch ≥3cm, Metabolic syndrome i.e. three or more of the following criteria: (waist circumference ≥35 inches, waist-hip ratio above 0.85, blood pressure ≥130/85 mmHg, fasting triglyceride (TG) level ≥150mg/dl, fasting high-density lipoprotein (HDL) cholesterol level ≤50mg/dl and fasting blood sugar ≥100mg/dl) and insulin resistance i.e. fasting glucose ≥l00mg/dL, 2-hour plasma glucose ≥140mg/dl, fasting insulin level ≥5µIU/mL and HbA1C between 5.7-6.4%. Patients were divided into two groups, Group I (n=25); the lipo-abdominoplasty group and Group II (n=25); the liposuction only group. The change in the metabolic profile and insulin resistance was followed 3- and 6-months post operatively by measuring waist circumference, waist-hip ratio, blood pressure, fasting triglyceride, fasting high-density lipoprotein (HDL) cholesterol level, fasting blood sugar, fasting insulin, and fasting glucose level using specific laboratory equation called Homeostasis Model Assessment (HOMA-IR).

Results: For both groups, there is a significant improvement in glycaemic and lipid profile for all studied patients together with weight loss and BMI. but there was no difference in glycemic or lipid profile between both groups. Waist/hip ratio was significantly improved in lipo-abdominoplasty group more than liposuction only group. There was no relation between amount of resected fat and the improvement in glycemic and lipid profile for all patients.

Conclusion: As a part of body contouring surgeries, liposuction and lipo-abdominoplasty could play a role in improvement of insulin resistance and metabolic syndrome in patients with localized abdominal obesity. So, one time, it may not only be considered as an aesthetic procedure to improve the individual body image, but also it can be approved by the authorities and insurance companies as it affects the wellbeing.

Correspondence to: Dr. Abraham Hosny Shawky
E-Mail: Abraham.younan93@gmail.com

Key Words: *Abdominoplasty – Liposuction – Fat – Obesity – Metabolic profile.*

Disclosure: No conflict of interest.

INTRODUCTION

The localized abdominal obesity is the excess deposition of fat in the abdominal region which is related to a various and a common health condition **[1,2]**. The metabolic syndrome is one of these common associated comorbidities. In this syndrome, several known cardiovascular risk factors co-occur i.e., insulin resistance, obesity, atherogenic dyslipidemia and hypertension **[3]**.

Regarding insulin resistance, it is the impaired response to insulin stimulation at target tissues **[4]**. It results in weight gain which is strongly associated with insulin resistance **[5]**. It is also associated with disturbed lipid metabolism and dyslipidemia **[6]**.

In patients with localized abdominal obesity, the deposited fat not only affects the body image, but it also plays an endocrinological role and behaves as an active dynamic endocrine organ i.e., can secrete various hormones. One of these hormones is leptin, which is a small protein regulates the total body fat by reducing adipocytes lipid deposits **[7]** by inhibiting lipogenesis and stimulating lipolysis. So, it counteracts insulin, i.e., leptin inhibits insulin and insulin stimulates leptin in both synthesis and secretion **[8]**.

So, the subcutaneous adipose tissue (SAT) specially the deep layer is functionally like visceral adipose tissue (VAT) and the amount of deep SAT

is strongly affect both metabolic syndrome and insulin resistance **[9]**. Moreover, the SAT regulates leptin secretion which indirectly reflects the level of insulin sensitivity in the body. Thus, the removal of SAT could potentially affect the metabolic profile and insulin resistance **[10,11,12]**.

PATIENTS AND METHODS

This study was conducted at Plastic, Burn and Maxillofacial Surgery Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt. and approved by Research Ethics Committee (REC) of the same institution under number (FWA 000017585). The procedure was explained to all participants before obtaining a written informed consent.

At the outpatient clinic attached to the department, all women in the age range between 20-45 years complaining from localized abdominal obesity and wanted to improve their body image were investigated regarding insulin resistance and metabolic syndrome. Patients were examined clinically for skin signs related to insulin resistance as acanthosis nigricans and skin tags **[13]** and the following laboratory tests were requested to confirm the diagnosis; fasting glucose ≥l00mg/dL, fasting insulin level ≥5μ unit/ml, HbA1C between (5.7-6.4%) and HOMA-IR >1.9 **[14]**.

Also, the metabolic syndrome was considered if ≥3 of the following criteria was found waist circumference ≥35 inches, waist-hip ratio above 0.85, blood pressure ≥130/85mmHg, fasting triglyceride (TG) level ≥150mg/dl, fasting high-density lipoprotein (HDL) cholesterol level ≤50mg/dl in women and fasting blood sugar (≥100mg/dl) **[3,15]**.

A total number of 50 women were included in this study. We excluded Participants with already diagnosed insulin resistance or metabolic syndrome and controlled on treatment, who were scheduled for multiple procedures, diabetics, smokers, patients with renal, chronic liver disease, chronic lung disease, ischemic heart disease, pregnant, and lactating women, or participants who take drugs that can affect lipid profile (such as Statins) or insulin sensitizers (such as Biguanides and Thiozolidinediones) or on anticoagulants.

All included patients were examined clinically by senior author for suitability to either liposuction only or Lipo-abdominoplasty. Thereafter, they were photographed and divided into two groups. Group I (n=25); the lipo-abdominoplasty group and Group II (n=25); the liposuction only group. All the surgical interventions were done by the senior author.

Patient evaluation: The change in the metabolic profile and insulin resistance was followed 3- and 6-months post-operatively by measuring waist circumference, waist-hip ratio, blood pressure, fasting triglyceride, fasting high-density lipoprotein (HDL) cholesterol level, fasting blood sugar, fasting insulin, and fasting glucose level using specific laboratory equation called Homeostasis Model Assessment for insulin resistance (HOMA-IR). All measurements were compared to preoperative results for all studied patients and between both groups.

RESULTS

In this work, a total number of 50 female patients were included. Their age ranged from 20 to 45 years (33.92±6.76). For all patients, the mean pre-intervention weight was (89.32kg) that is reduced at 3 months and 6 months to 78.26kg and 76.83 respectively. Also, BMI was decreased from 30.17 to 24.50 and 24.12 at 3- and 6- months. Regarding glycemic control, the fasting insulin level was improved from 15μIU/mL to 10μIU/mL and 7μIU/mL at 3 and 6 months respectively. HOMA-IR was reduced from 2 to 0.8 and 0.6 at 3 and 6 months respectively. The 2 hours plasma glucose was also improved from 168.06 to 124.60 at 3 months and 126.17 at 6 months. The HbA1c was reduced from 6.68 to 5.14 and 5.20 at 3 and 6 months respectively. Total Cholesterol was reduced from 244.18 to 182.76 and 189.36 at 3- and 6- months respectively. LDL was lowered from 135.78 to 89.12 and 91.84 respectively. Triglycerides was decreased from 158.68 to 123.90 and 124.30 at 3 and 6 months respectively (Table 1). So, there is a significant improvement in glycaemic and lipid profile for all studied patients together with weight loss and BMI.

Comparing glycemic control and metabolic profile between both groups (Tables 2,3) there was no significant difference between the results comparing each other except for waist/hip ratio that was improved in group I; lipoabdominoplasty group from 0.88 preoperatively to 0.74 at 3- months that remained at the same ratio at 6- months (Fig. 1).

In group I, the mean of total volume of lipoaspirate was 2091.86 and the weight of resected skin was 2686.44gm. In group II, the mean amount of total lipoaspirate calculated in each group shown in (Table 4). There is no significant relation between the volume of resected subcutaneous fatty tissue and its fasting insulin level and HOMA-IR (Table 4 & Fig. 2).

Table (1): The Anthropometric, Glycemic and lipid profile for all studied patients at 48 hours before intervention 3- and 6-months post intervention.

Variable	Normal range	Range in Metabolic Syndrome and Insulin Resistance (women)	All participants (N=50)				
			Before intervention (Mean)	Post intervention (Mean)		*p*-value	Significance
			48 hours	3 months	6 months		
Anthropometric Measures:							
Weight (kg)			89.32±7.24	78.26±8.23	76.83±8.31	0.021	Significant
BMI	18.5-24.9		30.17±4.62	24.50±3.21	24.12±3.16	0.031	Significant
Waist/hip ratio	≤0.85	≥0.85	0.89±0.03	0.73±0.04	0.74±0.03	0.002	Highly significant
Glycemic Profile:							
Fasting insulin level (µIU/mL)	2-25	≥5	15 (12.2-17.5)	10 (7-12)	7 (3.5-5.2)	0.001	Highly significant
Fasting blood glucose (mg/dl)	≤100	≥100	134.98±27.14	95.19±10.96	92.13±5.82	0.022	Significant
HOMA-IR	<2	>1.9	2	0.8	0.6	0.003	Highly significant
2h plasma glucose (mg/dl)	<140	>140	168.06±41.28	124.60±33.54	126.17±32.67	0.001	Highly significant
HbA1c	<5.7	5.7-6.4	6.68±0.74	5.14±0.62	5.20±0.57	0.025	Significant
Lipid Profile:							
Total Cholesterol (mg/dl)	<200	–	244.18±33.15	182.76±34.08	189.36±34.06	0.044	Significant
LDL (mg/dl)	<100	–	135.78±27.20	89.12±33.14	91.84±33.37	0.005	Highly significant
HDL (mg/dl)	≥60	<40	39.58±9.56	58.26±9.48	51.72±9.60	0.001	Highly significant
TG (mg/dl)	<150	>150	158.68±23.15	123.90±11.43	124.30±12.41	0.003	Highly significant

p-value >0.05: Nonsignificant. *p*-value <0.05: Significant. *p*-value <0.01: Highly significant.

Table (2): Group I: The lipo-abdominoplasty group; 48 hours before intervention 3- and 6-months post intervention.

Variable	Normal range	Range in Metabolic Syndrome and Insulin Resistance (women)	Group I (N=25)				
			Before intervention (Mean)	Post intervention (Mean)		*p*-value	Significance
			48 hours	3 months	6 months		
Anthropometric Measures:							
Weight (kg)			89.22±8.44	79.56±7.20	77.13±7.81	0.031	Significant
BMI	18.5 -24.9		29.95±5.52	24.40±2.81	23.56±2.26	0.038	Significant
Waist/hip ratio	≤0.85	≥0.85	0.88±0.03	0.74±0.03	0.74±0.02	0.012	Significant
Glycemic Profile:							
Fasting insulin level (µIU/mL)	2-25	≥5	15(13-20)	11 (8-14)	8 (6-9)	0.045	Significant
Fasting blood glucose (mg/dl)	≤100	≥100	127.40±37.47	93.19±5.56	94.13±4.02	0.041	Significant
HOMA-IR	< 2	>1.9	2	0.9	0.6	0.001	Highly significant
2h plasma glucose (mg/dl)	<140	>140	159.06±23.28	133.60±13.54	136.17±30.67	0.004	Highly significant
HbA1c	<5.7	5.7-6.4	6.57±0.14	5.34±0.62	5.17±0.50	0.030	Significant
Lipid Profile:							
Total Cholesterol (mg/dl)	<200	–	245.30±32.25	172.76±34.08	176.16±34.06	0.032	Significant
LDL (mg/dl)	<100	–	128.28±27.10	80.12±23.14	85.04±23.17	0.004	Highly significant
HDL (mg/dl)	≥60	<40	36.58±9.56	58.16±9.48	64.72±9.50	0.001	Highly significant
TG (mg/dl)	<150	>150	165.18±23.25	133.90±12.43	141.30±12.41	0.006	Highly significant

p-value >0.05: Nonsignificant. *p*-value <0.05: Significant. *p*-value <0.01: Highly significant.

Table (3): Group II: The liposuction only group; 48 hours before intervention 3- and 6-months post intervention.

Variable	Normal range	Range in Metabolic Syndrome and Insulin Resistance (women)	Group II (N=25)				
			Before intervention (Mean)	Post intervention (Mean)		*p*-value	Significance
			48 hours	3 months	6 months		
Anthropometric Measures:							
Weight (kg)			89.02±7.50	78.28±2.20	77.52±3.81	0.025	Significant
BMI	18.5-24.9		29.17±4.62	24.40±2.11	23.16±2.06	0.040	Significant
Waist/hip ratio	≤0.85	≥0.85	0.86±0.03	0.85±0.43	0.85±0.42	0.093	Non-significant
Glycemic Profile:							
Fasting insulin level (µIU/mL)	2-25	≥5	15 (13.8-19)	13 (9-14)	9 (8-11)	0.049	Significant
Fasting blood glucose (mg/dl)	≤100	≥100	125.52±12.14	89.47±2.56	90.53±3.02	0.031	Significant
HOMA-IR	< 2	>1.9	2	1	0.7	0.001	Highly significant
2h plasma glucose (mg/dl)	<140	>140	145.06±33.28	121.60±15.54	125.17±18.67	0.006	Highly significant
HbA1c	<5.7	5.7-6.4	6.55±0.14	5.17±0.12	5.24±0.22	0.037	Significant
Lipid Profile:							
Total Cholesterol (mg/dl)	<200	–	232.30±32.25	157.16±12.08	149.16±15.06	0.025	Significant
LDL (mg/dl)	<100	–	119.30±27.10	94.12±13.10	87.04±11.19	0.029	Significant
HDL (mg/dl)	≥60	<40	38.28±7.16	61.16±9.18	58.92±9.50	0.001	Highly significant
TG (mg/dl)	<150	>150	164.18±23.25	147.80±11.43	123.10±11.41	0.009	Highly significant

p-value >0.05: Nonsignificant. *p*-value <0.05: Significant. *p*-value <0.01: Highly significant.

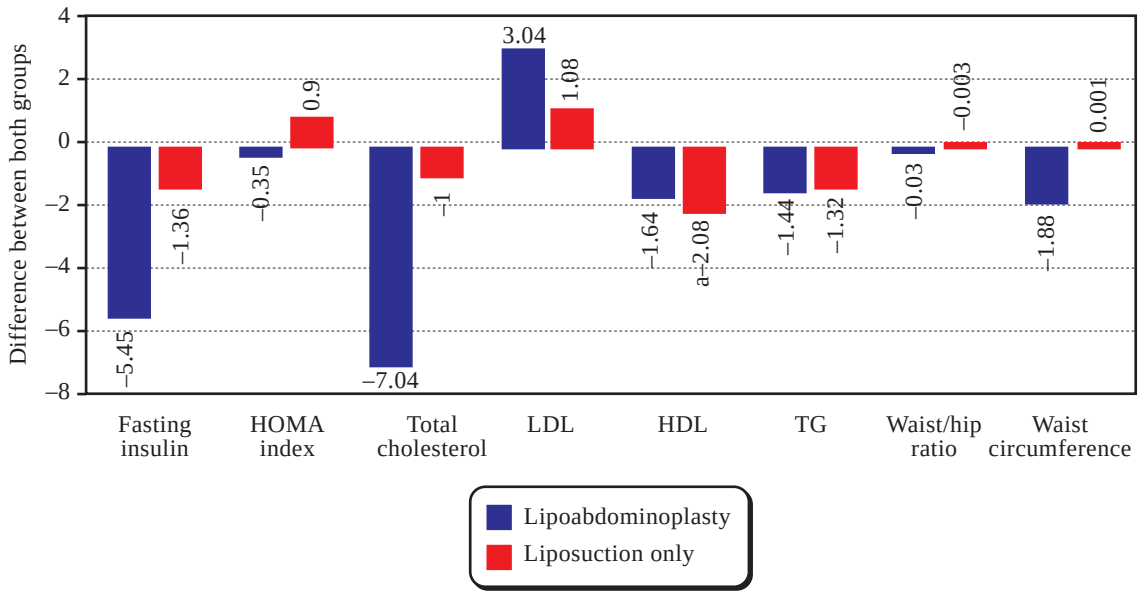

Fig. (1): The glycemic control, metabolic profile, and anthropometric measures between both groups with no significant difference except in waist-hip ratio, which improved in Group I.

Table (4): The mean volume of total lipoaspirate and amount of resected subcutaneous tissue calculated in each group.

	Group I	Group II
Volume of lipoaspirate (ml)	500-3000 (2091.86±640.31)	1500-4000 (2500.00±813.5)
Amount of resected subcutaneous tissue (gm)	1400-4000	–

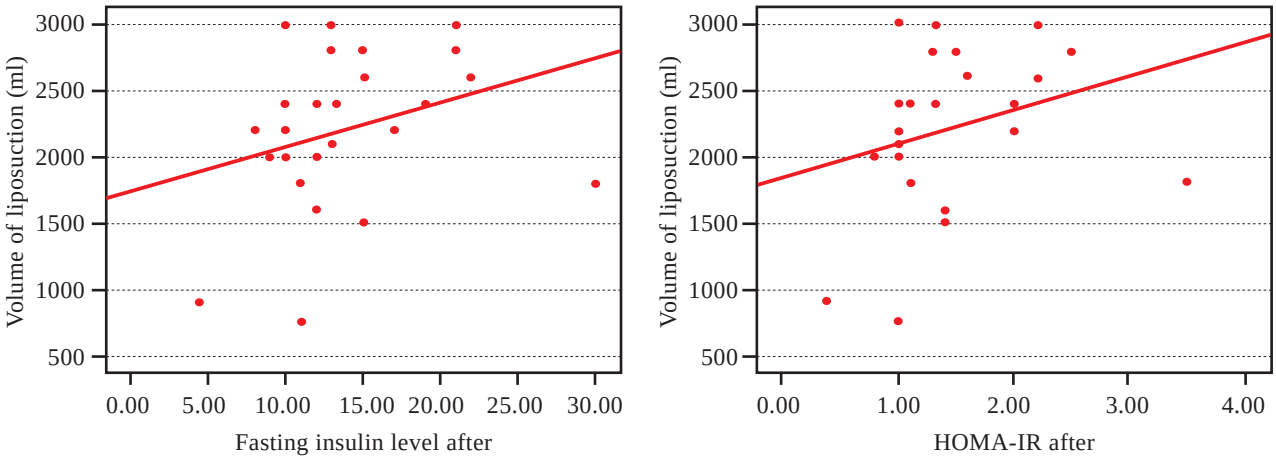

Fig. (2): The relation between mean volume of total lipoaspirate for all participants and fasting insulin level and HOMA-IR.

DISCUSSION

Nowadays, it is settled that localized abdominal obesity is strongly related with hyperinsulinemia. But there is a scarce evidence-based support the association between the subcutaneous adipose tissue (SAT) with insulin resistance and metabolic profile in contrary to visceral adipose tissue (VAT) **[10]**.

So, it is important to correlate between body contouring surgeries and its effect on general health and wellbeing as this concept will open the horizon to include these esthetic surgeries to be covered under any insurance umbrella.

In a similar study was done Gibas-Dorna and her colleagues on 17 overweight diabetic men, for them, liposuction only was performed with reported improvement of insulin sensitivity, reduction in weight and BMI **[16]**. We studied a larger number of patients (50) and all of them weren't diabetics or even prediabetics. A combined clinical and laboratory survey was done to all patients complaining from localized abdominal obesity and wanted to improve the abdominal contour. Then, who was diagnosed with metabolic syndrome, higher insulin levels and insulin resistance was followed the abdominal wall contouring regarding the glycaemic control and lipid profile. We noticed improvement in both groups with no significance importance between the procedure of SAT removal.

So, it is the effect of removing SAT not the type of procedure. This concept was proved by the study of Ramos-Gallardo and his peers who studied the effect of lipo-abdominoplasty on lipid profile in dyslipidemic 26 women with improvement of their lipid profile at the end of study. They studied the effect of resistin which is a protein secreted by fat tissue responsible for increased the production of LDL and degrading of the LDL receptors in the liver. So, SAT removal can lower the resistin level and consequently, decrease the production of LDL by the liver that will improves the dyslipidemia **[17]**.

In this study, we didn't find a relation between the amount of removed fat and the insulin resistance. This may be explained by that it is a matter of removing all harmful excess fat for every individual patient rather than getting rid of a specific volume. So, there is no cut point at which the insulin resistance will improve i.e., the more volume to be removed not mean a better response but all extra fat should be removed.

Another point that was noticed in this work that the waist-hip ratio decreased much more in lipo-abdominoplasty group than liposuction only group. This could be referred to the effect of myofascial plication that is performed routinely in lipo-abdominoplasty.

Another observation and despite that body contouring surgeries are not a weight loss procedure, it is noticed that there is a loss in total body weight and BMI in all participants. This can be attributed to the improvement in patient's self-steam with the acceptable aesthetic results that encouraged them to start regular exercise with diet program and lifestyle modification.

Conclusion:

As a part of body contouring surgeries, Fat removal either by Liposuction only or combined lipo-abdominoplasty is important not only for better aesthetic outcome but also, it plays an important role in improvement of insulin resistance and metabolic syndrome in patients in a way similar

to removal of visceral adipose tissue. So, one-time and beside the axial role abdominal contouring surgeries to improve the individual body image, it can be approved by the authorities and insurance companies as a health-related intervention.

REFERENCES

1- DHAWAN D. and SHARMA S.: Abdominal Obesity, Adipokines and Non-communicable Diseases. The Journal of steroid biochemistry and molecular biology, 203: 105737, 2020.

2- Papaetis G.S., Papakyriakou P. and Panagiotou T.N.: Central obesity, type 2 diabetes and insulin: Exploring a pathway full of thorns. Archives of medical science: AMS, 11 (3): 463-482, 2015.

3- SWARUP S., GOYAL A., GRIGOROVA Y. and ZELTSER R.: Metabolic Syndrome. In StatPearls. StatPearls Publishing, 2021.

4- Deacon C.F.: Physiology and Pharmacology of DPP-4 in Glucose Homeostasis and the Treatment of Type 2 Diabetes. Frontiers in Endocrinology, 10: 80, 2019.

5- Verkouter I., Noordam R., le Cessie S., van Dam R.M., Lamb H.J., Rosendaal F.R., van Heemst D. and de Mutsert R.: The Association between Adult Weight Gain and Insulin Resistance at Middle Age: Mediation by Visceral Fat and Liver Fat. Journal of Clinical Medicine, 8 (10): 1559, 2019.

6- Bjornstad P. and Eckel R.H.: Pathogenesis of Lipid Disorders in Insulin Resistance: A Brief Review. Current Diabetes Reports, 18 (12): 127, 2018.

7- Arabpour-Dahoue M., Mohammadzadeh E., Avan A., Nezafati P., Nasrfard S. and Ghazizadeh H.: Leptin level decreases after treatment with the combination of Radiofrequency and Ultrasound cavitation in response to the reduction in adiposity. Diabetes & metabolic syndrome, 13 (2): 1137-1140, 2019.

8- Pruksapong C., Chamnanchanunt S., Thanachartwet V., Desakorn V., Nakawiro D., Sahassananda D. and Rojnuckarin P.: Association of Body Dysmorphic Disorder with Leptin Levels in Patients with Normal Weight Undergoing Liposuction: A Matched Case Study. Plastic and reconstructive surgery. Global Open, 7 (10): e2482, 2019.

9- De Lucia Rolfe E., Ong K.K., Sleigh A., Dunger D.B. and Norris S.A.: Abdominal fat depots associated with insulin resistance and metabolic syndrome risk factors in black African young adults. BMC Public Health, 15: 1013, 2015.

10- Gibas-Dorna M., Turkowski P., Bernatek M., Mikrut K., Kupsz J. and Piątek J.: Liposuction-induced metabolic alterations the effect on insulin sensitivity, adiponectin, leptin and resistin. Journal of Medical Science, 84 (4): 249-256, 2015.

11- Kim S.H., Chung J.H., Song S.W., Jung W.S., Lee Y.A. and Kim H.N.: Relationship between deep subcutaneous abdominal adipose tissue and metabolic syndrome: A case control study. Diabetology & Metabolic Syndrome, 12 (8): 10, 2016.

12- Ghafoor L., Entezari V., Fallah A. and Hajian A.: Lipoabdominoplasty and the leptin hormone. Annals of Medicine and Surgery, 68: 102633, 2021.

13- Freeman A.M. and Pennings N.: Insulin Resistance. In StatPearls. StatPearls Publishing, 2021.

14- American Diabetes Association; 2. Classification and Diagnosis of Diabetes (2021): Standards of Medical Care in Diabetes-2021. Diabetes Care 1 January, 44 (Supplement 1): S15-S33, 2021.

15- Casadei K. and Kiel J.: Anthropometric Measurement. In Stat Pearls. Stat Pearls Publishing, 2021.

16- Gibas-Dorna M., Szulińska M., Turkowski P., Kupsz J., Sowińska A., Mikrut K., Bernatek M. and Piatek J.: The Effect of VASER Abdominal Liposuction on Metabolic Profile in Overweight Males. American Journal of Men's Health, 11 (2): 284-293, 2017.

17- Ramos-Gallardo G., Pérez Verdin A., Fuentes M., Godínez Gutiérrez S., Ambriz-Plascencia A.R., González-García I., Gómez-Fonseca S.M., Madrigal R., González-Reynoso L.I., Figueroa S., Toscano Igartua X. and Jiménez Gutierrez D.F.: Effect of abdominoplasty in the lipid profile of patients with dyslipidemia. Plastic surgery international, 861348, 2013.