ORIGINAL ARTICLE

Effect of current glycemic control on qualitative body composition in sedentary ambulatory Type 2 diabetics

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ABSTRACT

Background: Obesity and Type 2 diabetes mellitus are on rise with cause–effect relationship. Diabetics monitor blood sugar, neglecting qualitative body composition, leaving residual threat of ectopic fat unattended. We tried to correlate glycemic triad with parameters of body composition derived objectively by bioelectrical impedance analysis (BIA). **Materials and Methods:** A sample of 78 under treatment sedentary Type 2 diabetics of either sex with known glycemic and lipidemic control from our city. Following baseline assessment measurement was done by instrument Omron Karada Scan (Model HBF-510, China) using the principle of tetra poplar BIA to derive parameters of body composition. We tried to correlate glycemic triad with these parameters, both directly as well as after defining them as per established cutoff norms. **Results:** We found poor glycemic control in the study group (20% for Hb1AC), high body mass index, subcutaneous fat, visceral fat (VF), total body fat (TBF), and lesser mass of skeletal muscle in Type 2 diabetics. However, there were small, insignificant, and inconsistent difference of these parameters while directly correlating with the fasting blood sugar, postprandial blood sugar, and glycosylated hemoglobin. On qualitative assessment, the impact of glycemic control as per standard norms, the risk of high VF, high TBF, low skeletal muscle mass was though high (between 1 and 2) in Type 2 diabetics with poor glycemic control as compared to good glycemics, but each strength lacks statistical significance. **Conclusion:** BIA reveals that Type 2 diabetics have more ectopic fat on expense of skeletal muscle that do not correlate with current glycemic status, both quantitatively and qualitatively. Measurement of body composition can be included and subjects can be motivated for lifestyle modification strategies while managing metabolic derangements of Type 2 diabetes.

Key words: Bioelectrical impedance analysis, body composition, glycemic triad, Type 2 diabetes

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INTRODUCTION

India is facing a shift from undernutrition to overnutrition,[1] later producing obesity and its aftermaths like Type 2 diabetes mellitus (T2DM). There is alarming rise of T2DM in India,[2] a country with an ethnic predisposition for it. Insulin resistance proceeded by obesity is the link between T2DM and cardiovascular deaths[3] and at least the first event can be monitored and prevented primarily to stop this chain of progression. However, there is a lack of awareness regarding obesity and optimum body composition which are not given importance as due as glycemic control measurement and maintenance in case of known T2DM subjects.[4] Body mass index (BMI), though defining obesity, falls short of qualitative inference of body composition[5] while the modern imaging techniques that overcomes this deficit are far from reach in our community to the most. Bioelectric impedance analysis (BIA) provides an objective, cost-effective method of qualitative and quantitative body composition analysis with proven efficacy in our

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population[6] with inference about visceral fat (VF) that is a risk factor itself and a negative affecter for glycemic control.[7] However, once diagnosed what is the effect of these parameters on body composition especially body fat, remains a question. We conducted this study to find the impact of glycemic control using glucose triad on BIA derived parameters of body composition in terms of both quantity and quality.

MATERIALS AND METHODS

We conducted a cross-sectional observational study from January 2013 to April 2014 in Clinical Research Lab, Physiology Department of our Medical College.

Sample size of 78 for current population of city 6,00,000 and prevalence of T2DM 7.33% in urban area of our state[8] gave us 90% confidence interval keeping margin for error 5% as calculated by sample size calculator software GraphPad in Stat 3 software (demo version free software of GraphPad Software, Inc., California, USA).

Following approval from the institutional review board and informed consent from participants, the study was carried out in under treatment ambulatory sedentary Type 2 diabetics. Subjects were recruited from medicine outpatient department (OPD) of a tertiary care teaching hospital attached to our medical college and from private OPDs.

About 78 Type 2 diabetics (44 males and 34 females) were undertaken in the age group 30–80 years, living sedentary life, not taking insulin, taking regular medicines, and having a recent investigation for glycemic or lipidemic control. To make the sample heterogeneous, we included patients with and without hypertension, with and without statin therapy, with or without family history of Type 2 diabetes, coming from various socioeconomic statuses so as to make a fairly representative sample of the population.

To evaluate glycemic control of the Type 2 diabetics subjects underwent measurement of (1) fasting blood sugar (FBS) and postprandial blood sugar (PP2BS) done by GOD-POD method (2) glycosylated hemoglobin (HbA1c) done by immunoturbidimetry method. These tests were done as a recent report by fully auto analyzer I LAB-650/MIURA, A-1004 at NAAC certified Biochemistry department of our college using standard SOPs. We defined glycemic control as per criteria laid by American Diabetes Association 2014,[9] and good glycemic control was defined as (1) HbA1c ≤7 g %, (2) FBS ≤126 mg%, and (3) PP2BS ≤180 mg %. Subjects were divided into two groups based on these criteria into those with good or poor glycemic control.

Subjects meeting inclusion and exclusion criteria were undertaken for the study with initial assessment in the form of personal history, medical history, anthropometric measurement, and recent reports of glycemic controls including, FBS, PP2BS, and HbA1c, and lipidemic control.

After entering age, gender, and height taken by stadiometer subject was allowed to stand on the instrument after its calibration. A digital, portable, noninvasive instrument Omron Karada Scan (Model HBF-510, China) working on the principle of tetra polar bioelectrical impedance analysis was used that passes electric current of 500 μA at frequency 5 kHz to scan the whole body to derive regional body composition. We enrolled ambulatory outdoor patients only and took the reading in the morning so as to avoid dehydration[10] that otherwise would affect the accuracy of this method.

For qualitative analysis, we defined standard norms as-1 (BMI ≤252) (VF ≤103) total body fat (TBF) and skeletal muscle mass as per standard guidelines.[11]

Statistical analysis

The data were transferred on Excel spreadsheet, and descriptive analysis was expressed as a mean ± standard deviation. All calculations were accomplished by GraphPad InStat 3 software. We evaluated the difference between of these body composition parameters among groups based on glycemic control quantitatively by Student's *t*-test and qualitative risk calculation by Odds ratio using defined cutoff norms of body composition parameters. Any observed difference was considered statistically significant with $P < 0.05$.

RESULTS

Table 1 shows baseline data of study group reflecting the participation of both sexes, average duration of Type 2 diabetes 7.5 years, high average BMI, good lipidemic control, and poor glycemic control with respect to HbA1c.

Table 2 shows direct quantitative correlation between values of BIA derived parameters of body composition with means of glycemic control, namely, HbA1c, FBS, and PP2BS reflecting that subjects, regardless the glycemic status, showed the high-fat low muscle mass pattern of body composition which is slightly more so in case of poor glycemics, yet statistically insignificant in most instances.

To get a clear picture for correlation, we defined cutoff points for variables, namely, BMI, VF, TBF, skeletal muscle mass, and tried to calculate odds risk ratio for their abnormality owing to exposure to uncontrolled blood sugar for all three measures of glycemic triad. This qualitative comparison showed that there was small, inconsistent, and insignificant odds risk of poor glycemic control (HbA1c, FBS, and PP2BS) on parameters of body composition with none bearing adequate strength of association [Table 3].

Table 1: Base line data of case group under study

Feature	Value
General features (mean±SD)	
Age (years)	52.8±9.49
Gender (*n*)	
Male	44
Female	34
Total	78
Duration of diabetes (years)	7.53±5.82
Height (cm)	160.1±7.88
Weight (kg)	69.66±11.69
BMI (kg/m²)	27.19±4.67
Lipidemic control-value (mean±SD)	
Total cholesterol (mg/dL)	149.91±45.20
HDL-C (mg/dL)	46.39±13.16
LDL-C (mg/dL)	90.18±29.34
VLDL-C (mg/dL)	18.50±11.95
Triglycerides (mg/dL)	120.83±59.21
Lipidemic control-prevalence, *n* (%)	
Triglycerides (mg/dL)	58/78 (74)
HDL-C (mg/dL)	52/78 (67)
LDL-C (mg/dL)	48/78 (62)
Glycemic control-values (mean±SD)	
HbA1c (g/dL)	8.78±1.72
FBS (mg/dL)	142.70±50.99
PP2BS (mg/dL)	192.18±71.91
Glycemic control-prevalence, *n* (%)	
HbA1c (g/dL)	16/78 (21)
FBS (mg/dL)	44/78 (56)
PP2BS (mg/dL)	39/78 (50)

PP2BS – Postprandial blood sugar; FBS – Fasting blood sugar; BMI – Body mass index; SD – Standard deviation; HDL-C – High-density lipoprotein cholesterol; LDL-C – Low-density lipoprotein-cholesterol; VLDL-C – Very low-density lipoprotein

Table 2: Quantitative comparison of parameters of body fat distribution among groups based on glycemic control (defined by therapeutic goals ADA guidelines 2014)

Parameter	Uncontrolled	Controlled	*P*
HbA1c			
Weight	70.69±11.77	67.06±11.33	0.22
BMI	27.58±4.42	26.18±5.22	0.24
TBF	34.51±5.97	32.54±6.24	0.20
VF	12.01±4.57	11.73±5.98	0.82
SF	31.73±7.75	27.27±6.84	0.02*
SF/VF ratio	2.93±1.14	2.90±1.49	0.52
Skeletal muscle mass	23.18±4.54	23.92±4.42	0.91
FBS			
Weight	71.11±12.13	68.98±11.33	0.33
BMI	27.76±5.11	26.73±4.28	0.33
TBF	35.46±5.96	32.73±5.95	0.04*
VF	12.86±6.14	11.18±3.66	0.14
SF	30.98±7.45	30.05±8.01	0.60
SF/VF ratio	2.79±1.11	3.03±1.34	0.32
Skeletal muscle mass	22.82±4.15	23.85±4.75	0.40
PP2BS			
Weight	70.24±12.36	69.08±11.11	0.66
BMI	27.58±5.38	26.80±3.86	0.47
TBF	34.42±6.22	33.50±5.96	0.50
VF	12.56±6.13	11.31±3.40	0.27
SF	30.00±8.58	30.94±6.85	0.59
SF/VF ratio	2.82±1.30	3.02±1.19	0.50
Skeletal muscle mass	29.99±8.58	30.94±6.85	0.60

BMI – Body mass index; VF – Visceral fat; PP2BS – Postprandial blood sugar; FBS – Fasting blood sugar; SF – Subcutaneous fat; TBF – Total body fat

DISCUSSION

Obesity has officially been declared a disease by American Medical Association in 2013 and India is no different to other countries when it comes to seriousness of its increasing magnitude that too with unique attributes. India shares one-third of the total burden of T2DM[4] worldwide that is further compounded by obesity doubling the cost of its management.[12] For given BMI, South Asians have greater adiposity and visceral and ectopic adipose tissue accumulation.[13] Few studies have revealed more adverse fat distribution at BMI >21 kg/m^2 in South Asians as compared with Caucasians in whom considerable dyslipidemia and dysglycemia are unseen until BMI exceeds 30 kg/m^2.[14] In previous studies, in Type 2 diabetics of our region, we found poor glycemic control and high prevalence of many preventable risk factor.[15] We also found that Type 2 diabetics have more ectopic fat on expense of skeletal muscle that persists even after matching by weight or BMI, both quantitatively and qualitatively.[16] With this propensity, it seems quite worthful to know body composition and body fat, in particular, both quantitatively and qualitatively in not only high-risk obese subjects but also in Type 2 diabetics with respect to current glycemic control.

T2DM patients of our study had high BMI, VF, subcutaneous fat (SF), TBF, and lesser muscle mass that is attributed to high mean age, average duration of disease 7.5 years, poor glycemic control and sedentary lifestyle, apart from disease itself. We found no effect of glycemic control on parameters of body fat distribution measured indirectly by BIA in ambulatory sedentary T2DM subjects, for almost all three of glycemic triad in terms of both quality and quantity with exception of TF-FBS and SF-HbA1c. This is similar to a recently reported study.[17] Correction of hyperglycemia decreases the risk of microvascular complications but macrovascular complications to a lesser extent that otherwise represent the primary cause of mortality with heart attacks and stroke accounting for around 80% of all deaths.[3,18,19] Most diabetic patients undergo regular scrutiny of glycemic and lipidemic control, and when it comes to body composition, BMI is perhaps only option offered to the most. However, BMI falls short of many qualitative inferences especially VF, which can be objectively measured by BIA. Obesity is the primary event, and one of the risk factor for T2DM and once T2DM ensues all measures turn to secondary in this regard.

T2DM, a multifaceted metabolic derangement, is more a disease of abnormally altered lipid metabolism than merely that of carbohydrates.[20] It is evident now that it

Table 3: Qualitative comparison of parameters of body fat distribution (defined by standard cut off norms) among groups based on glycemic control (defined by therapeutic goals ADA guidelines 2014)

	BMI >25	BMI ≤25	Odds risk	95%CI	*P*
HbA1c >7	40	16	2.08	0.75-5.77	0.16
HbA1c ≤7	12	10			
FBS >130	30	11	1.86	0.72-4.82	0.20
FBS ≤130	22	15			
PP2BS >180	27	12	1.26	0.49-3.24	0.63
PP2BS ≤180	25	14			
	VF >10	VF ≤10			
HbA1c >7	46	10	2.15	0.69-6.63	0.18
HbA1c ≤7	15	7			
FBS >130	32	9	2.08	0.75-5.78	0.16
FBS ≤130	29	8			
PP2BS >180	29	10	0.63	0.21-1.88	0.41
PP2BS ≤180	32	7			
	TBF > threshold	TBF < threshold			
HbA1c >7	48	12	1.14	0.32-4.10	0.84
HbA1c ≤7	14	4			
FBS >130	28	32	1.37	0.47-4.03	0.56
FBS ≤130	7	11			
PP2BS >180	32	28	1.43	0.50-4.12	0.51
PP2BS ≤180	8	10			
	Skeletal muscle < threshold	Skeletal muscle > threshold			
HbA1c >7	55	15	0.52	0.06-4.60	0.56
HbA1c ≤7	7	1			
FBS >130	32	38	0.84	0.19-3.64	0.82
FBS ≤130	4	4			
PP2BS >180	36	34	1.06	0.25-4.58	0.94
PP2BS ≤180	4	4			

CI – Confidence interval; BMI – Body mass index; TBF – Total body fat; VF – Visceral fat; PP2BS – Postprandial blood sugar; FBS – Fasting blood sugar

is not the disordered glucose metabolism but rather the chronic elevation of free fatty acid that is the culprit for T2DM.[21] Diabetic patients target blood sugar and blood lipid control at the same time neglecting the deranged pattern of body composition in the form of increased ectopic fat at expense of protein that is associated with higher cardiovascular comorbidities.[22] VF has now proven to bring about Insulin resistance that leads to diabetes and there are evidence based on bariatric surgery[23] and exercise intervention studies[17] that reduced VF improves glycemic status as well as insulin resistance. However, the situation is further compounded by the facts that treatment for diabetes itself causes adiposity,[24] preventive pharmacotherapy has the least effect on optimizing body composition,[25] mild to moderate exercise affects body fat little,[26] and Indians are most vulnerable to obesity.[4] There are fallacies while relating glycemic status and body compositions such as effect of glycemic variability making current glycemic status not completely reliable,[27] poor glycemic control in Indian diabetics[28] especially with regard to HbA1c, use of subjective methods such as waist-hip ratio,[29] no glycemic threshold for micro or macrovascular complications of T2DM[30] and ethnic vulnerability of Indians for obesity-related complications.[4]

Obesity is a disease and not a choice.[4] Prevention of weight gain is one of the therapeutic goals for T2DM patients.[31] Many rely solely on statins which in the absence of other lifestyle interventions are ineffective to optimize body composition as shown by our another work.[32] We also found current lipidemic control to affect body fat only insignificantly. Weight reduction is good not only for improving glycemic control but also for reduction of cardiovascular risk.[33] Weight regain is very common, and weight loss is difficult to maintain.[34] Subjects can be motivated for optimum body composition by regular BIA scan for body fat and self-monitoring can definitely be reinforced. One can be motivated for lifestyle modifications such as diet plans, exercise, and smoking cessations that can serve as measures of secondary prevention achieved by self-care in T2DM subjects and measures of primary prevention in those at risk by self-awareness, in both the cases, helping to fight against modern epidemic of obesity and its aftermath T2DM.

This study has few limitations such as its cross-sectional nature, small sample size, presence of risk factors which cannot be eliminated and the method which is based on a predictive formula, tending to underestimate body fat. However, it showed that in T2DM patients, abnormality of body composition especially VF has no correlation with glycemic status, hence requiring special attention for knowing, targeting, and achieving optimum body composition using simple methods such as BIA to make sure that prevention turns better than cure.

CONCLUSION

We found no correlation of current glycemic status with abnormally elevated ectopic fat and reduced muscle mass in under treatment sedentary Type 2 diabetics, suggesting the need for qualitative body composition by methods like BIA, optimizing it by lifestyle modifications, and maintaining it to reduce adverse outcomes in an attempt to fight against obesity.

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Conflicts of interest
There are no conflicts of interest.

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