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ORIGINAL RESEARCH ARTICLE

VISCERAL FAT VERSUS SUBCUTANEOUS FAT: COMPARISON OF THEIR ASSOCIATION WITH TYPE 2 DIABETES MELLITUS

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ABSTRACT

To compare abdominal visceral fat with subcutaneous fat in relation to their association with type 2 diabetes. Abdominal fat distribution was measured using Computed Tomography in 60 subjects (30 diabetics and 30 non-diabetics). Computed tomography images obtained at two intervertebral locations L2-L3 and L4-L5 were used to measure areas of total fat, visceral fat and subcutaneous fat using slice thickness of 5mm and attenuation range of -190 to -30 Hounsfield units. Data were analyzed using logistic regression. At L2-L3 level, taking visceral fat and subcutaneous fat as predictor variables, diabetes was correctly classified at 78.0% and 66.10% respectively. At L4-L5 level, taking visceral fat and subcutaneous fat as predictor variables, diabetes was correctly classified at 72.88% and 67.80% respectively. Regardless of the measurement site, visceral fat has significantly stronger association with diabetes, compared to subcutaneous fat. Visceral fat at L2-L3 level alone may be a better predictor of diabetes. Abdominal fat distribution, visceral fat, subcutaneous fat, type 2 diabetes.

Key Words: *Abdominal fat distribution, Subcutaneous fat, Type 2 diabetes, Visceral fat.*

INTRODUCTION

In November 14, 2012, International Diabetes Federation published new data indicating the enormity of the diabetes epidemic. The number of people known to be affected worldwide has soared to 371 million in 2012 with global prevalence of 8.3% in adults. [1] IDF also estimates that 187 million people (50%) with diabetes are undiagnosed. Prevalence of diabetes in Nepal is 3.05% (506.73 thousand adults). [2] Number of adult with undiagnosed diabetes in Nepal is estimated 1,120.3 thousands. Type 2 diabetes mellitus (T2DM) accounts for 90 to 95% of the incidence of diabetes. [3] Although previously T2DM was predominantly diagnosed in middle-aged or older people, it has now begun to show up in teenagers and children.

Abdominal subcutaneous fat (SCF) is located immediately beneath the skin and on top of abdominal musculature. Visceral fat (VF) is located in the body cavity beneath the abdominal muscles. VF depots are composed of the greater omentum, lesser omentum and the mesenteric fat. A lesser amount of VF is located retroperitoneally. In general, VF accounts for 10-20% of total fat (TF) in men and 5–8% in women. [4,5] SCF accounts for about 80% of TF. [5]

Obesity is probably the most powerful predictor in development of T2DM. [6] Increasing evidence has accumulated to demonstrate that regional adiposity plays a greater role in development of diabetes and impaired glucose tolerance than generalized obesity. While abdominal obesity is determined by the accumulation of both SCF and VF, the excess accumulation of VF appears to play a more significant pathogenic role. [4, 7-13] Compared to SCF, VF is much more strongly linked to insulin resistance and T2DM. [4,7-10,14] However, controversy still exists regarding the contribution of subcutaneous and visceral fat in the development of diabetes. Some have reported both contributing to insulin resistance in T2DM. [15-18] Others have documented that VF is associated with an increased incidence of metabolic syndrome and has significantly stronger relation with insulin resistance and diabetes.[7-10,14, 19] SCF is not consistently reported to be a significant correlate of metabolic syndrome or its individual component. However, some [20-24] studies have shown associations between SCF, insulin resistance and diabetes. This study aims to compare VF with SCF regarding their association with T2DM.

RESEARCH DESIGN AND METHODS

This prospective correlational study was carried out in Gandaki Medical College with study sample consisting of 60 subjects between 20 and 70 years of age. Among them 30 were diabetics (male18; female12) and 30 were non-diabetics (male15; female15). The diabetic subjects were selected from a cohort of people with known T2DM who received abdominal Computed Tomography (CT) scan in Gandaki Medical College. Inclusion criteria for diabetic subjects were age between 20 to 75 years, T2DM and no severe chronic diabetic complications. Non-diabetic subjects were selected at the same hospital, from the cohort of people who had received an abdominal CT scan for examination of lumbar spine. Those with any apparent health problem except mild lumbar spine degeneration were excluded.

Height and weight were measured in all subjects before proceeding to CT scanning and the body mass indices [BMI = weight in kg /(height in m)²] were calculated.

Abdominal fat distribution was measured in all subjects by CT using a TOSHIBA ASTEION 4 slice CT scanner. Subjects were examined in supine position with both arms stretched above the head. An initial scan was taken from a lateral view to establish the bony landmarks on a radiograph of the skeleton as a reference. Contiguous transverse images were acquired from vertebral body L2 to vertebral body L5. The scan was performed at 120 kV and 150 mA with a 5 mm slice thickness. For each subject, an axial image obtained at midway between L2 and L3, and another one at midway between L4 and L5 were identified for measuring abdominal fat. TF area was estimated by demarcating the whole abdomen scan with a computerized pen and calculating the contained adipose tissue using an attenuation range of -190 to -30 Hounsfield Units (Fig. 1). Cross-sectional VF area was calculated by applying the same attenuation range and delineating the inner margin of the abdominal musculature surrounding the abdominal cavity. SCF area was determined by delineating the outer margin of the abdominal musculature using same method and subtracting the obtained area from the TF area. Statistical analyses were performed using STATA version 9.1. Group data are presented as means ± SD. Comparison between VF and SCF regarding their association with diabetes was done using logistic regression analysis adjusted for age, sex and BMI.

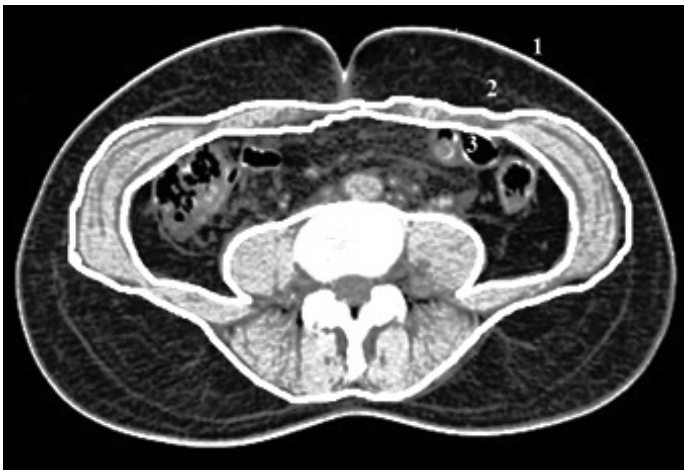

Figure 1. Illustration of method for determining abdominal fat distribution on a CT image scanned at L4-L5 plane.
TF = Fat area within perimeter 1
VF = Fat area within perimeter 3
SCF = Fat area within perimeter 1 minus fat area within perimeter 2

RESULTS

Subject characteristics are listed in Table 1. Mean values of BMI, TF area and VF area were highest in diabetic men. Irrespective of sex and diabetic status, mean values of TF area and SCF area were higher at L4-L5 level. Likewise, Irrespective of sex and diabetic status, mean value of VF area was higher at L2-L3 level. In men, TF, VF and SCF were higher in diabetic men irrespective of the measurement site. In women, TF and SCF were higher in non-diabetics while VF was higher in diabetics irrespective of measurement site. Increased BMI was noted in diabetic men while BMI was normal with non-diabetics and diabetic women.

Table 1: Baseline characteristics of 60 subjects; Data are means ± SD

	Diabetics (n=30)	Nondiabetics (n=30)
MALE		
n	**18**	**15**
Age (years)	50.17 ± 10.1	44.7 ± 14.08
BMI (kg/m²)	26.11 ± 3.83	24.23 ± 2.6
TF area L2-L3 (cm²)	322.82 ± 110.29	233.74 ± 96.46
TF area L4-L5 (cm²)	339.69 ± 126.2	239.2 ± 87.34
VF area L2-L3 (cm²)	196.62 ± 58.57	129.48 ± 68.35
VF area L4-L5 (cm²)	155.65 ± 62.38	86.66 ± 37.39
SCF area L2-L3 (cm²)	113.48 ± 54.42	91.56 ± 30.15
SCF area L4-L5 (cm²)	175.46 ± 82.77	133.45 ± 51.17
FEMALE		
n	**12**	**15**
Age (years)	55.0 ± 7.36	47.75 ± 12.7
BMI (kg/m²)	23.877 ± 2.14	23.92 ± 2.25
TF area L2-L3 (cm²)	255.23 ± 58.2	260.56 ± 86.8
TF area L4-L5 (cm²)	300.43 ± 84.4	334.37 ± 87.55
VF area L2-L3 (cm²)	125.13 ± 42.71	107.38 ± 43.27
VF area L4-L5 (cm²)	105.02 ± 44.87	97.19 ± 32.26
SCF area L2-L3 (cm²)	118.36 ± 26.96	136.91 ± 47.42
SCF area L4-L5 (cm²)	182.09 ± 58.33	218.62 ± 60.61

Associations of VF and SCF with diabetes are shown in Table 2 as correctly classified percent values computed using logistic regression with VF and SCF areas as predictor variables for diabetes. This analysis was adjusted for age, sex and BMI. Irrespective of the measurement site, VF had significantly higher correctly classified value for predicting diabetes than SCF. VF area measured at L2-L3 correctly classified diabetes at a higher percent than at L4-L5. For SCF areas, correctly classified percent values obtained at L2-L3 and L4-L5 were not significantly different.

Table 2. Correctly classified values for diabetes with respect to VF and SCF areas as the predictor variables.

Predictor variable	Diabetes correctly classified	
	L2-L3	L4-L5
VF	**78.0 %** sensitivity = 82.76 % specificity = 73.33 %	**72.88 %** sensitivity = 68.97 % specificity = 76.67 %
SCF	**66.10 %** sensitivity = 68.97 % specificity = 63.33 %	**67.80 %** sensitivity = 68.97 % specificity = 66.67 %

Logistic regression analysis was adjusted for age, sex and BMI.

DISCUSSION

Visceral fat, being portally drained and lipolytically more active,[10,25] is a powerful independent predictor of insulin resistance in T2DM. [9,10,14,26] Many studies have documented that VF is associated with increased incidence of metabolic syndrome and has significantly stronger relation with insulin resistance and diabetes. [7-10,14,19] Findings in this study corroborates with previous studies as this study (table 2) shows that visceral fat has a stronger association with development of diabetes compared to subcutaneous fat independent of measurement site.

It is as well reported that the greatest deposition of omental and mesenteric fat is located in the upper abdomen within the region between intervertebral locations L1-L2 and L3-L4[10,25,27] This study shows that there is greater amount of visceral fat at L2-L3 level (table 1) which is in consistent with previous studies. Thus, visceral fat at L2-L3 level might be expected to have a stronger association with the development of diabetes than visceral fat at L4-L5 or subcutaneous fat at any measurement site. This observation is relevant to the findings in this study. An important finding of this study (Table 2) was that visceral fat at L2-L3 level was much more strongly associated with the development of diabetes than visceral fat at L4-L5 level which is the traditional landmark for measuring abdominal fat distribution. These findings can have important implications as it suggests that visceral fat at intervertebral location L2-L3 alone may be a better predictor of diabetes. This study also shows that greater deposition of TF and SCF lies at L4-L5.

There are limitations of this study that should be noted. The sample size is relatively small. In addition, there were only 4 obese subjects. Rest were either overweight or with normal BMI. A larger sample size and inclusion of more frankly obese subjects would be appropriate to confirm the results in this study.

CONCLUSION

While visceral fat has stronger association with diabetes compared with subcutaneous fat, visceral fat at L2-L3 level alone plays greater role in the development of type 2 diabetes. The findings may prove useful in understanding visceral and central obesity and may have relevance to clinical assessment, prevention and treatment of diabetes.

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