Correlation and Comparison of Epicardial Adipose Tissue with Sagittal Abdominal Diameter and Other Anthropometric and Biochemical Variables of Metabolic syndrome

Meenaxi Sharda¹, Harish Nigam³, SR Meena¹, Anil Soni², Anuraj Singh³, Nitasha Sharma³

Abstract

Objective: 1) To determine relation of epicardial adipose tissue (EAT) thickness with sagittal abdominal diameter (SAD) and other anthropometric measurements in metabolic syndrome (MetS). 2) To determine relation of epicardial adipose tissue with biochemical variables of metabolic syndrome.

Methods: Cases were recruited from the patients attending OPD in New Medical College Hospital, Govt. Medical College, Kota, Rajasthan, India between March 2015 to February 2016. Informed consent was obtained from all participants after taking permission from hospital ethical committee. Patients were categorized as cases and controls according to IDF criteria for MetS. We obtained receiver operating characteristic (ROC) curve of EAT for determination of cut-off values.

Results: Epicardial adipose tissue thickness had significant positive correlation with fasting blood sugar (r = 0.49), sagittal abdominal diameter (r = 0.48), body mass index (r = 0.47), LDL cholesterol (r = 0.34), waist circumference (r = 0.33), waist hip ratio (r = 0.32), triglycerides (r = 0.31) and total cholesterol (r = 0.29). Epicardial adipose tissue thickness had significant negative correlation with HDL cholesterol (r = -0.34). EAT thickness (cm) was greater in metabolic syndrome cases (0.515 ± 0.07 vs 0.338 ± 0.06; p < 0.0001). Optimal cut off of EAT in metabolic syndrome is 0.425 cm according to ROC curve at which test is 96% sensitive and 83 % specific.

Conclusion: EAT has shown good correlation with SAD and other anthropometric measurements as well as biochemical parameters of metabolic syndrome. Optimal cut off value of EAT to predict metabolic syndrome is 0.425 cm. FBS and Triglycerides are more closely associated with EAT. HDL Cholesterol is better correlated to SAD while LDL cholesterol is best correlated to WC.

Editorial Viewpoint

• Various parameters are being correlated with biochemical variables of metabolic syndrome.
• This study finds relation of epicardial adipose tissue with sagittal abdominal diameter in metabolic syndrome.
• EAT has good correlation with SAD with optimal cut off of EAT has 0.425 cms to predict metabolic syndrome.

Introduction

Cardiovascular disease will likely become a major public health and clinical problem in South Asia (India, Pakistan, Bangladesh, Nepal). Estimates from the Global Burden of Disease Study suggest that by the year 2020 India will have more individuals with atherothrombotic cardiovascular disease than any other region¹. Metabolic and cardiovascular diseases are well known to be more prevalent in obese individuals than non-obese individuals. More specifically, increased visceral adipose tissue, the fat that surrounds the internal organs (e.g., heart, intestines) in the cavities of the body, predicts an unfavorable cardiovascular and metabolic risk profile. For example,
visceral adiposity is strongly correlated with diabetogenic features (e.g., impaired insulin sensitivity, increased insulin levels), atherogenic features (e.g., increased triglycerides, decreased high density lipoproteins), prothrombotic factors (e.g., increased fibrinogen, Factor VII, plasminogen activator inhibitor 1) and proinflammatory cytokines (e.g., interleukin-6 [IL-6] and tumor necrosis factor-a [TNF-a]).

Though waist circumference is considered as an accepted measure of intra abdominal adiposity, it confounds subcutaneous adipose tissue in more obese individual. Waist circumference as measure of visceral obesity may be less reliable in older persons.

Body mass index, an anthropometric measure of visceral adiposity is suggested to be a poorer indicator of cardiovascular risk than waist-circumference across ethnicities, suggesting that body-mass index may not be a very good measure of visceral obesity.

Sagittal abdominal diameter (SAD) was first demonstrated by Kvist et al 1988 to be a good correlate of visceral adipose tissue volume, observed by CT scan. Sjostrom et al 1994 proposed use of SAD in assessment of visceral fat mass. Richelsen and Pedersen 1995 confirmed its value in assessing abdominal fat and prediction of metabolic risk. Measuring SAD in supine position reflects the width of intra abdominal fat in the antero-posterior plane.

In light of the above limitations of anthropometric measurements and lack of practicality of existing methods and the recognition that more reliable measures of visceral adiposity are needed, Iacobellis et al 2003 proposed the direct measurement of epicardial adipose tissue (EAT) thickness via echocardiography as a marker for visceral adiposity. Epicardial adipose tissue has been shown to be very closely related to intra-abdominal adiposity, a marker of entire body visceral adiposity, according to various magnetic resonance imaging studies.

Study Objective

(1) To determine relation of epicardial adipose tissue with sagittal abdominal diameter and other anthropometric measurements in metabolic syndrome cases. (2) To determine relation of epicardial adipose tissue with biochemical variables of metabolic syndrome.

Material and Methods

Cases were recruited from the patients attending OPD in New Medical College Hospital, Govt. Medical College, Kota, Rajasthan, India between March 2015 to February 2016.

Sample size: By simple random method 110 cases (>18 years) were selected. These cases were divided into 2 groups.

Group 1- Cases with metabolic syndrome

Group 2- Cases without metabolic syndrome

Inclusion criteria

1. Patients attending medical OPD who were willing to participate in study were included.
2. Diagnosis of metabolic syndrome was according to IDF Criteria.

International Diabetes Federation (IDF) consensus worldwide definition of the metabolic syndrome is as below:

Central obesity (defined as waist circumference with ethnicity specific values. For South Asians males ≥ 90 cm and females ≥ 80 cm) and any two of the following:

a. Raised triglycerides: > 150 mg/dl or specific treatment for this lipid abnormality.

b. Reduced HDL cholesterol: <40 mg/dl in males, <50 mg/dl in females or specific treatment for this lipid abnormality.

c. Raised blood pressure: systolic BP >130 or diastolic BP >85 mm Hg or treatment of previously diagnosed hypertension.

d. Raised fasting plasma glucose >100 mg/dl or previously diagnosed type 2 diabetes.

Exclusion Criteria: Subjects with

1. Spinal deformity
2. Abdominal tumors, lump
3. Significant ascites
4. Pathological diseases (cancer, renal and hepatic diseases and chronic inflammatory pathologies)
5. In whom anthropometry measurements are not feasible.
6. In whom acoustic window is not satisfactory for transthoracic echocardiography.
7. Pericardial effusion as a diagnosis by echocardiography.

Detailed history was taken and scrutiny of previous medical record was done. A thorough clinical examination of all patients were done in each subject. Complete laboratory work up included:-

a. Complete blood count, urine complete
b. Renal and liver function tests
c. Fasting and postprandial plasma glucose (glucose peroxidase method)
d. Lipid profile: Serum total cholesterol, HDL, LDL, VLDL and triglycerides
e. Standard 12 lead ECG
f. X-Ray chest PA view
g. Thyroid profile

Anthropometric measurements such as weight (kg), height (cm), waist circumference (cm), hip circumference (cm), body mass index (BMI), waist hip ratio (WHR) and sagittal abdominal diameter (SAD) were measured.

Sitting right arm brachial blood pressure was measured twice in interval of 10 minutes by mercury sphygmomanometer and average value was considered for new diagnosis of cases. The patients were considered as having
hypertension based on previous medical records also.

Weight and height was measured while the subjects were barefoot and wearing light clothing.

Body mass index (BMI) was calculated from formula: $\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2 (m^2)}$. WHO (modified) classification for BMI of Indo-Asian patients is used: Normal: 18-22.9, Overweight: 23-25, Obese: 25-30, Morbid Obesity: more than 30.

Waist circumference (WC) was measured according to WHO criteria in standing position after normal expiration, midway between the lower rib margin and the iliac crest (WHO).

Waist-hip ratio is the index of regional distribution of body fat which is used in the epidemiological research. It is based on the ratio between the waist circumference values and the hip circumference.

Waist hip ratio of 0.80 and more in female and 0.90 and more in males is considered as abnormal and subjects are considered as having abdominal obesity.

SAD or “supine abdominal height” was measured after a normal expiration to nearest 0.1 cm in supine position with straight legs on a firm examination table using portable sliding-beam indigenous made abdominal calliper. This instrument was handmade under our supervision by an artisan and SAD was measured at the level of iliac crest (L4-5) without clothes in the measurement area.

Echocardiographic Assessment of Epicardial Adipose Tissue

Each subject underwent transthoracic two-dimensional (2D) guided M-mode echocardiogram. Echocardiograms was performed with a Micromaxx Ultrasound System Sonosite instrument by standard techniques with subjects in the left lateral decubitus position by an experienced echocardiographer who was blindfolded. We measured epicardial fat thickness at end diastole on the free wall of right ventricle from both parasternal long and short axis views. We made sure that the epicardial fat thickness
Table 1: Mean, standard deviation and p value of various parameters in metabolic syndromes cases and controls

<table>
<thead>
<tr>
<th>Metabolic syndrome</th>
<th>Cases</th>
<th>Controls</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>56.55±8.87</td>
<td>57.19±7.48</td>
<td>0.687</td>
</tr>
<tr>
<td>FBS</td>
<td>128.53±11.53</td>
<td>98.56±10.07</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>HDL</td>
<td>42.02±4.6</td>
<td>48.97±6.95</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>TG</td>
<td>176.8±16.08</td>
<td>135.48±14.09</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>TC</td>
<td>199.42±11.04</td>
<td>178.00±8.81</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>LDL</td>
<td>121.88±10.87</td>
<td>102.72±9.10</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>WC</td>
<td>91.70±6.05</td>
<td>76.06±7.85</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>WHR</td>
<td>1.02±0.03</td>
<td>0.95±0.046</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>BMI</td>
<td>27.28±1.34</td>
<td>22.93±2.06</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>SAD</td>
<td>23.67±1.97</td>
<td>19.33±1.33</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>EAT</td>
<td>0.51±0.07</td>
<td>0.33±0.06</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Table 2: Variables correlated with EAT in metabolic syndrome cases

<table>
<thead>
<tr>
<th>Variables correlated with EAT</th>
<th>Pearson coefficient (r)</th>
<th>P value</th>
<th>Correlation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBS</td>
<td>r = 0.496</td>
<td>P = 0.0001</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>HDL</td>
<td>r = -0.341</td>
<td>P = 0.01</td>
<td>Negative</td>
<td>Yes</td>
</tr>
<tr>
<td>LDL</td>
<td>r = 0.346</td>
<td>P = 0.009</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>TC</td>
<td>r = 0.298</td>
<td>P = 0.02</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>TG</td>
<td>r = 0.314</td>
<td>P = 0.018</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>WC</td>
<td>r = 0.33</td>
<td>P = 0.012</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>WHR</td>
<td>r = 0.323</td>
<td>P = 0.015</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>BMI</td>
<td>r = 0.47</td>
<td>P = 0.0002</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>SAD</td>
<td>r = 0.48</td>
<td>P = 0.0001</td>
<td>Positive</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 3: Correlation between anthropometric measurements and cardiovascular risk factors in metabolic syndrome cases

<table>
<thead>
<tr>
<th>Metabolic syndrome</th>
<th>FBS</th>
<th>HDL</th>
<th>TG</th>
<th>LDL</th>
<th>TC</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAT</td>
<td>0.49</td>
<td>-0.34</td>
<td>0.31</td>
<td>0.34</td>
<td>0.29</td>
</tr>
<tr>
<td>SAD</td>
<td>0.40</td>
<td>-0.36</td>
<td>0.30</td>
<td>0.38</td>
<td>0.12</td>
</tr>
<tr>
<td>WC</td>
<td>0.22</td>
<td>-0.26</td>
<td>0.24</td>
<td>0.42</td>
<td>0.21</td>
</tr>
<tr>
<td>BMI</td>
<td>0.19</td>
<td>-0.21</td>
<td>0.18</td>
<td>0.28</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Results

Statistical methods used were unpaired student t test and Pearson correlation coefficient using bivariate analysis by Graph Pad Instant Version. We also obtained ROC Curve (Receiver Operating Characteristic Curve) of EAT in relation to metabolic syndrome to obtain optimum cut-off value of EAT.

In our study of 110 individuals, 56 are metabolic syndrome cases (males 29 and females 27) and 54 are controls (males 28 and females 26). Values are in mean±S.D.

Table 1 shows anthropometric and biochemical variables of participants. All variables except HDL Cholesterol were significantly higher in metabolic syndrome cases when compared to controls (p < 0.0001).

Table 2 presents correlation of EAT with various variables. The Pearson coefficient were significant (p < 0.05)

Table 3 shows correlation between anthropometric measurements and cardiovascular risk factors in tissue on the right ventricle, with optimal cursor beam orientation in each view. Hypertrophy of the right ventricle trabecula and moderator band, even if it occurred, did not confound epicardial adipose tissue calculation. Echocardiography is a non-invasive and safe. It is also relatively cost and time efficient and a commonly advised test for routine assessment of patients.

were not measured obliquely because it falsely increases measurements. Measurements on M-mode strips obtained from both 2D views with longitudinal cursor beam orientation in each view was also performed (Figures 1, 2). The maximum values at any site was measured, and the average value was taken. Epicardial adipose tissue appears as an echo-free or a hyperechoic space, if it is massive. The measurement of epicardial fat on the right ventricle is chosen for two reasons: 1) this point is recognized as the highest absolute epicardial fat layer thickness, and 2) parasternal long and short axis views allow the most accurate measurement of epicardial adipose
metabolic syndrome cases.

We also obtained ROC curve (Receiver Operating Characteristic Curve) of EAT for prediction of metabolic syndrome (Figure 1). ROC curve shows the trade-off between sensitivity and specificity (any increase in sensitivity will be accompanied by decrease in specificity).

Optimal cut off of EAT to diagnose metabolic syndrome in cases is 0.425 cm according to ROC curve at which test is 96% sensitive and 83% specific.

**Discussion**

**EAT and MetS**

Epicardial adipose tissue (EAT) thickness (cm) is significantly associated with metabolic syndrome in our study (0.515 ± 0.07 vs 0.338 ± 0.06; p < 0.0001). Similar results were also found in Lima-Martinez et al 2013 who concluded that significant association exists between EAT thickness and both metabolic syndrome components and adiponectin concentration, a link that might be used as a biomarker for this disease. Epicardial adipose tissue thickness values were found to have a greater significance in the metabolic syndrome group than in the control group (5.69 ± 1.12 vs. 3.52 ± 0.80; p = 0.0001). In study by Balcioğlu et al 2014 showed Epicardial adipose tissue thickness (5.8 ± 1.9 mm vs. 4.3 ± 1.6 mm, p < 0.001) and plasma homocysteine levels (21.6 ± 6.1 μmol/L vs. 15.1 ± 5.8 μmol/L, p < 0.001) were significantly higher in the Metabolic Syndrome group. Iacobellis, et al 2003 first suggested the use of echocardiography to determine EAT, and in subsequent studies, EAT was found to be higher in patients with MetS. Pierdomenico, et al 2011 found that EAT was increased in patients with both hypertension and MetS even if body weight were normal with an acceptable WC. Stramaglia, et al 2010 measured EAT by echocardiography and abdominal fat tissue by DEXA in elderly patients with MetS; the authors found that both abdominal fat thickness and EAT were increased in the elderly patients with MetS, but only EAT was associated with MetS.

In our study EAT is significantly correlated positively with fasting blood sugar (Pearson coefficient r = -0.341; p = 0.010). Similar results were found in study by Balcioğlu et al 2014 where HDL was also negatively correlated with EAT (r = -0.21). Iacobellis et al also concluded that HDL is negatively correlated with EAT [r = -0.50 (males) and r = -0.51 (females)]

**LDL cholesterol is also significantly correlated positively with EAT thickness** (Pearson coefficient r = 0.34; p = 0.009). Lima-Martinez et al 2013 concluded that epicardial fat thickness showed a statistically significant positive correlation with insulin plasma levels (r = 0.505; p = 0.0001), Tg/HDL-C ratio (r = 0.447; p = 0.0001), and non-HDL-C (r = 0.353; p = 0.007); and a statistically significant negative correlation with plasma concentrations of adiponectin (r = 0.499; p = 0.0001). There was no correlation between hs-CRP and EAT thickness. Iacobellis et al 2003 showed positively correlation between LDL and EAT thickness [r = 0.60 (males) and r = 0.59 (females)].

**Triglycerides is significantly correlated positively with EAT thickness** (Pearson coefficient r = 0.341; p = 0.018). Iacobellis et al 2003 showed positively correlation between triglycerides and EAT [r = 0.38 (males) and r = 0.37 (females)]. Balcioğlu et al 2014 also concluded positive correlation between triglycerides and EAT thickness (r = 0.38).

Waist circumference is positively and significantly correlated to EAT thickness (Pearson coefficient r = 0.33; p = 0.01). Balcioğlu et al 2014 showed positively correlation between waist circumference and EAT thickness (r = 0.28). Fernandez Munoz et al 2014 also concluded positively correlation between waist circumference and EAT thickness (r = 0.32). In study by Kaya et al 2015 the Pearson correlation analysis demonstrated positive correlation between EAT thickness and waist circumference (r = 0.36).

The correlation analysis in study by Lima-Martinez et al 2013 also showed positive correlation between EAT thickness and waist circumference (r = 0.6). Iacobellis et al 2003 also demonstrated positive correlation between EAT and waist circumference (r = 0.84).

**Waist Hip Ratio is positively and significantly correlated to EAT thickness** (r = 0.32; p = 0.012). In a study by Cristina Silaghi et al 2011 there was a significant correlation (p < 0.05) between EAT thickness and waist circumference. EAT is not correlated with BMI (p = 0.315), hip circumference (p = 0.45), hip circumference (p = 0.82), nor with waist/hip ratio.

**Body mass index is also significantly correlated positively with EAT thickness** (Pearson coefficient r = 0.47; p = 0.0002). In study by Iacobellis et al 2014 there was significantly positive correlation between body mass index and EAT (r = 0.56). Balcioğlu et al 2014 showed positive correlation between EAT and BMI (r = 0.42). The correlation analysis in study by Lima-Martinez et al 2013 revealed that epicardial fat thickness showed a statistically significant positive correlation with BMI (r = 0.66; p = 0.0001). In a study by Cristina Silaghi et al 2011 EAT is not correlated with BMI (p = 0.315).

**Waist Hip Ratio (WHR) and epicardial adipose tissue show**
significant positive correlation (Pearson coefficient $r = 0.32$). In study by Ana Carolina et al$^{12}$ 2013 EAT and WHR had positive correlation ($r = 0.36$)

**EAT and SAD**

In our study sagittal abdominal diameter (SAD) has significant positive correlation with epicardial adipose tissue (EAT) thickness (Pearson coefficient $r = 0.48$; $p = 0.0001$). In study by Ana Carolina et al$^{12}$ 2013 EAT and SAD had positive correlation ($r = 0.62$).

We also obtained ROC curve (Receiver Operating Characteristic Curve) of EAT for diagnosis of metabolic syndrome. ROC curve shows the trade-off between sensitivity and specificity (any increase in sensitivity will be accompanied by decrease in specificity).

Optimal cut off of EAT to diagnose metabolic syndrome in cases is 0.425 cm according to ROC curve at which test is 96% sensitive and 83% specific. Okay et al$^{13}$ 2008 reported that EAT thickness of >4.35 mm indicated MS according to International Diabetes Federation criteria. Lima-Martínez, et al$^{13}$ 2013 found that an EAT level above 5 mm demonstrated high sensitivity and specificity in predicting MetS with an AUC of 0.852 in a Venezuelan population aged 20–65 years. Our results differ from those reported by Iacobellis et al$^{14}$ 2003 who found in Caucasian subjects that EAT cut-off values of 9.5 mm and 7.5 mm increased the sensitivity and specificity for predicting MetS in males and females respectively. These differences are consistent with the findings of Pierdomenico et al$^{15}$ 2011 who showed that the difference in EAT thickness between subjects with and without MetS varies depending on ethnic group, being significantly greater in Caucasian subjects, followed by Hispanic, Turkish, and Asian subjects. Alexopoulos et al$^{14}$ 2010 also found significant differences in epicardial fat volume quantified by computed tomography between Caucasian (96 ± 44 mL) and Hispanic subjects (54 ± 17 mL). The reasons for these differences are not known, but they may possibly be due to racial variability in the amount and distribution of visceral adipose tissue, as previously reported in some ethnic groups. Ahn et al$^{13}$ 2008 showed that EAT thickness ≥3.0 mm was independently associated with the presence of coronary artery disease in both Korean men and women, and Natale et al$^{16}$ 2009. similarly reported that EAT thickness ≥7.0 mm was associated with the presence of subclinical atherosclerosis in both European men and women. Moreover, a lower EAT thickness (4.5 mm) showed a good sensitivity and specificity for detecting a low coronary flow reserve in Turkish women, while EAT values ≥6.5 mm predicted the occurrence of a hypertensive response in normotensive subjects undergoing a stress test in the same population.

Our study shows for LDL cholesterol WC has better correlation than SAD and EAT (Pearson correlation 0.42 vs 0.38 vs 0.34). EAT and SAD are better than WC to ascertain cardiometabolic risk factors especially FBS (Pearson correlation 0.49 vs 0.40 vs 0.22), Triglycerides (Pearson correlation 0.31 vs 0.30 vs 0.24). For HDL cholesterol SAD has better correlation than EAT and WC (Pearson correlation -0.36 vs -0.34 vs -0.26). Thus EAT and SAD both are equally good to capture elevated cardio metabolic risk when compared to waist circumference.

Our results correspond to those of other studies, in which echocardiographically-measured EAT values linked to anthropometric and clinical metabolic syndrome components.

Epicardial adipose tissue is a true visceral fat tissue, deposited around the heart on the free wall of the right ventricle and on the left ventricular apex, but also around the atria. Obesity seems to be a predisposing factor for the accumulation of excess epicardial fat. Body fat distribution, particularly abdominal fat tissue, is more strongly correlated to epicardial fat. A possible common pathway during embryogenesis could explain this finding. In fact, epicardial fat and intraabdominal fat seem to be originally in brown adipose tissue in infancy. The biochemical proprieties of epicardial adipose tissue suggest its possible role as a cardiovascular and metabolic risk indicator. Although waist circumference is widely accepted as a marker of adverse metabolic profile and high cardiovascular risk, it can be confounded by large amounts of subcutaneous fat, particularly in severely obese subjects.

Echocardiographic measurement of VAT would not be affected by this. In fact, we can obtain a true VAT measurement, avoiding the possible confounding effect of increased subcutaneous abdominal fat thickness. This may also explain the advantage of echocardiography over other ultrasound abdominal fat measurements. Our finding seems to support the observation that this echocardiographic measure could be a good imaging predictor of visceral fat mass and could justify its higher cost compared with a simpler measure, such as waist circumference. In any case, echocardiography requires lower costs than existing methodologies, such as MRI and computed tomography, also providing data on cardiac parameters that can be useful in the clinical management of patients with metabolic syndrome. Furthermore, echocardiography could have its greatest utility as a less expensive method for precise quantification of visceral fat for research and risk stratification purposes. We suggest that echocardiographic epicardial adipose tissue could be applied as an easy and reliable...
imaging indicator of cardiovascular risk. Also if abdominal caliper is available, SAD is also good indicator of cardio metabolic risk.

**Conclusion**

EAT has shown good correlation with SAD and other anthropometric measurements as well as biochemical parameters of metabolic syndrome. Optimal cut off value of EAT to predict metabolic syndrome is 0.425 cm. FBS and Triglycerides are more closely associated with EAT. HDL Cholesterol is better correlated to SAD while LDL cholesterol is best correlated to WC.

**Limitation of study**

Measurement of EAT may have some limitation. Firstly, no standardised technique is available for measurement of EAT. Secondly, we have not measured EAT by CT and MRI which are gold standard to measure EAT. Thirdly, EAT thickness varies with ethnicity. Future studies including all ethnic groups could help to shed further light on the matter of ethnicity. Fourthly, some percentage of technical and manual error could still be there by operating echocardiographer. Since abdominal caliper is not commercially available, SAD remains as an underutilized parameter to account MetS and predict cardiovascular risk. WC is widely accepted to predict MetS due to its practical implication. EAT and SAD due to less clinical feasibility is more used for research purposes.

**References**