Multiplicity of Dysmetabolic Components in Males is Associated with Elevated Cardiac Troponin T Concentrations

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Received date: June 11, 2014; Accepted date: June 23, 2014; Published date: June 26, 2014

Abstract

**Background:** There are multiple lines of evidence to suggest that chronic myocardial stress and increased cardiovascular risk is associated with the enhanced release of cardiac troponin in patients with ischemic heart disease. However, there is a paucity of data regarding the relation of cardiac troponin to the metabolic syndrome (MetS), a leading risk factor for cardiovascular morbidity.

**Methods:** We determined the prevalence of measurable high sensitivity cardiac Troponin T (hs-cTnT) with a fifth generation assay and evaluated its association to the presence of the male metabolic syndrome (MetS) components in a cohort of patients undergoing a health survey in the Tel Aviv Medical Center Inflammation Survey (TAMCIS).

**Results:** A total of 1,641 men with no known cardiovascular disease were recruited and MetS was diagnosed in 330 (20.1%) of them. Hs-cTnT concentrations were higher in patients with MetS (p<0.001). The number of MetS components was associated with the concentration of hs-cTnT (p<0.001 for trend). The 99th percentile concentration was 27.6 ng/l and 16.03 ng/l for those with and without the MetS, respectively. Five percent of patients with MetS had hs-cTnT concentrations higher than the 99th percentile predetermined by the manufacturer.

**Conclusions:** The MetS in males is associated with higher levels of hs-cTnT than the general population, with each component increasing hs-cTnT value.

**Keywords:** Metabolic syndrome; Troponin T; Cardiovascular risk

**Introduction**

There are multiple lines of evidence to suggest that chronic myocardial stress and increased cardiovascular risk is associated with the enhanced release of cardiac troponin in patients with coronary artery disease and in apparently healthy individuals [1-4]. Increased hs-cTnT levels had been described in some of the metabolic syndrome (MetS) components [5-7] and particularly in patients with diabetes and obesity. However, there is paucity of data regarding the relation of hs-cTnT to the MetS as a complex, and whether increasing number of MetS components is associated with increased troponin concentration and elevated cardiovascular risk.

We determined the prevalence of measurable hs-cTnT with a fifth generation assay, recently introduced into the Tel-Aviv Medical Centre Inflammation Survey (TAMCIS), [8-10] a relatively large health screening program of the Tel-Aviv Medical Center in Tel-Aviv, Israel. We then evaluated associations of cTnT with the MetS and its distinctive components.

**Methods**

**Study population**

We have analyzed data that has been collected during the period of September 2010 to June 2012 in the TAMCIS, a registered data bank of the Israeli ministry of justice [8-10]. This is a relatively large cohort of individuals who attended our medical center for a routine annual check-up and who gave their written informed consent for participation according to the instructions of the local ethics committee. Included were 1,891 male subjects for whom hs-cTnT were obtained. Based on the medical history found in the medical charts of TAMCIS, We later excluded 250 subjects due to any previous vascular event (myocardial infarction, pulmonary emboli, venous thromboembolism or a cerebrovascular accident), a previous diagnosis of ischemic heart disease or immunosuppressive therapy, steroidal or antibiotic treatment or recent acute infection or previous malignancy. Following these exclusions the study group was comprised of 1,641 apparently healthy males with no known cardiovascular disease.

**Definition of the metabolic syndrome**

The diagnosis of the metabolic syndrome was based on the joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention, National Heart, Lung, and Blood
Laboratory methods

All blood samples were drawn following a 12 hour fasting period. Cardiac troponin T levels were measured with a novel pre-commercial highly sensitive assay (Elecsys Troponin T; Roche Diagnostics, Indianapolis, IN), as described previously [4]. The lower limit of detection of the novel assay is 3ng/L. The coefficient of variation of <10% is 13 ng/L and the 99th percentile value for cTnT published by the manufacturer is 14 ng/L.

The complete blood count parameters were measured using a couler STKS electronic counter. Quantitative fibrinogen was measured by the Claus [12] method, and the high sensitivity C-Reactive Protein (hs-CRP) was measured by the Behring BN II Nephelometer (DADE Behring, Marburg, Germany) analyzer and a method described by Rifai et al. [13]. Triglycerides were measured by an adaptation of the fossati 3 step enzymatic reactions with the Bayer Advia 1650 chemistry analyzer. Serum triglycerides were determined calorimetrically with an enzyme that produces hydrogen peroxide [14]. HDL-C was determined by a method developed by Izawa et al as described before [15] using the Bayer Advia 1650 chemistry analyzer. LDL-C was derived from the measured concentrations of total cholesterol, HDL-C and triglycerides using the Fried waldeq equation: LDL-C=Total Cholesterol – HDL-C – TG/5.

Statistical Analysis

All continuous variables were displayed as mean (standard deviation [SD]), while categorical variables were displayed as number (percent) of patients within each group. Since the hs-cTnT displayed non-normal distribution, all analyses were non-parametric. Comparison of all continuous variables was done using the Mann-Whitney U analysis while for categorical variables the Fischer exact test was used.

The level of significance used for all analyses was two-tailed (p<0.05). The SPSS 19.0 statistical package was used to perform all statistical analyses (SSPS Inc., Chicago, IL, USA).

Results

We have presently included a total of 1,641 men, at a mean age ± SD [range] of 47.4 ± 10.1 [24-78] years. Demographic, medical history and laboratory values of subjects with and without the MetS are presented in Table 1. A diagnosis of the Metabolic Syndrome, according to the harmonized criteria was present in 330 (20.1%) subjects.

Table 1: Baseline characteristics according to the metabolic syndrome

<table>
<thead>
<tr>
<th>Laboratory data</th>
<th>Metabolic Syndrome</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol, mg/dL</td>
<td>184</td>
<td>186</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>101</td>
<td>179</td>
</tr>
<tr>
<td>LDL-C, mg/dL</td>
<td>51</td>
<td>40</td>
</tr>
<tr>
<td>eGFR, mL/min</td>
<td>80.5</td>
<td>77.8</td>
</tr>
<tr>
<td>hs-CRP, mg/L</td>
<td>1.9</td>
<td>2.8</td>
</tr>
<tr>
<td>Hemoglobin A1C, %</td>
<td>5.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Aspirin, %</td>
<td>4.3</td>
<td>14.8</td>
</tr>
<tr>
<td>Antihypertensive, %</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Statins, %</td>
<td>14.4</td>
<td>28.5</td>
</tr>
</tbody>
</table>

HDL-C – high density lipoprotein cholesterol, eGFR – estimated glomerular filtration rate, hs-CRP – high sensitive C-Reactive Protein.

The percentage of subjects with one, two, three, four and five components of the MetS was 20%, 31%, 28.8%, 14% and 5.1%, respectively. Mean and percentile values of hs-cTnT were calculated for each group. The 75th percentile for hs-cTnT was 3.88 ng/l and 5.4 ng/l for patients without and with MetS, respectively. The 25th and 50th percentiles were 3.0 for both. The 99th percentile was 16.03 ng/l and 27.6 ng/l for those without and with MetS, respectively. Data is presented in Table 2. Waist ≥ 94 cm (37 inches). HTN (hypertension) - ≥ 130 mm Hg systolic blood pressure or ≥ 85 mm Hg diastolic blood pressure or on antihypertensive drug treatment. IFG (Impaired Fasting Glucose) - ≥ 100 mg/dl (5.55 mmol/l) or ton glucose lowering treatment. TG (elevated triglycerides) - ≥ 150 mg/dl (5.55 mmol/l) or on drug treatment for elevated triglycerides. HDL (reduced HDL-C) was defined as <40 mg/dL (1.0 mmol/l) or on drug treatment for reduced HDL-C.
Table 2: hs-cTnT concentrations relation to Metabolic Syndrome components

<table>
<thead>
<tr>
<th>Positive MetS comp. *</th>
<th>Number of patients</th>
<th>Hs-cTnT concentrations ng/L</th>
<th>25th percentile</th>
<th>Median</th>
<th>75th percentile</th>
<th>99th percentile</th>
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<tbody>
<tr>
<td>Waist</td>
<td>959</td>
<td>3.0</td>
<td>35.8</td>
<td>3.0</td>
<td>4.7</td>
<td>19.1</td>
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<tr>
<td>HTN</td>
<td>783</td>
<td>3.0</td>
<td>35.8</td>
<td>3.0</td>
<td>5.0</td>
<td>18.9</td>
</tr>
<tr>
<td>IFG†</td>
<td>120</td>
<td>3.0</td>
<td>26.6</td>
<td>3.0</td>
<td>6.9</td>
<td>25.0</td>
</tr>
<tr>
<td>TG</td>
<td>343</td>
<td>3.0</td>
<td>35.8</td>
<td>3.0</td>
<td>4.5</td>
<td>27.4</td>
</tr>
<tr>
<td>HDL</td>
<td>355</td>
<td>3.0</td>
<td>35.8</td>
<td>3.0</td>
<td>4.1</td>
<td>18.5</td>
</tr>
</tbody>
</table>

Positive MetS comp. *

Number of positive MetS comp. *

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>Hs-cTnT concentrations ng/L</th>
<th>25th percentile</th>
<th>Median</th>
<th>75th percentile</th>
<th>99th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>329</td>
<td>3.0</td>
<td>43.8</td>
<td>3.0</td>
<td>10.6</td>
<td>35.4</td>
</tr>
<tr>
<td>1</td>
<td>509</td>
<td>3.0</td>
<td>35.8</td>
<td>3.0</td>
<td>3.8</td>
<td>16.6</td>
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<tr>
<td>2</td>
<td>473</td>
<td>3.0</td>
<td>24.6</td>
<td>3.0</td>
<td>4.7</td>
<td>16.3</td>
</tr>
<tr>
<td>3</td>
<td>229</td>
<td>3.0</td>
<td>28.7</td>
<td>3.0</td>
<td>5.4</td>
<td>25.6</td>
</tr>
<tr>
<td>4 or 5</td>
<td>101</td>
<td>3.0</td>
<td>35.8</td>
<td>3.0</td>
<td>6.0</td>
<td>35.6</td>
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</table>

<table>
<thead>
<tr>
<th>MetS</th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1,311</td>
<td>3.0</td>
<td>43.8</td>
<td>3.0</td>
<td>3.9</td>
<td>16.0</td>
</tr>
<tr>
<td>Yes</td>
<td>330</td>
<td>3.0</td>
<td>35.8</td>
<td>3.0</td>
<td>5.4</td>
<td>27.6</td>
</tr>
</tbody>
</table>

Hs-cTnT: High sensitive cardiac troponin T, MetS: Metabolic syndrome, Min: Minimum, Max- maximum, Comp: components.

* Positivity of MetS components was based upon the harmonized criteria.

A graphical presentation of hs-cTnT concentrations in individuals with and without the MetS is presented in figure 1. As can be seen, subjects with the MetS had higher measurements of hs-cTnT (p<0.001).

Box and whisker plots of the distribution of hs-cTnT: the bottom and top of the box represent the first and third quartiles (25th and 75th percentile), and the bold band inside the box is the second quartile (the median). The ends of the whiskers represent the lowest datum still within 1.5 the inter quartile range (IQR) of the lower quartile, and the highest datum still within 1.5 IQR of the upper quartile. The circles represent outliers in the range of 1.5 to 3 IQR and the stars represent extreme outliers, of more than 3 IQR.

The number of MetS components was associated with the level of hs-cTnT (p<0.001 for trend), with each additional component (e.g. increased waist circumference) increasing the hs-cTnT level (Figure 2).
Hs-cTnT concentrations for each of the metabolic syndrome components and according to the number of positive Mets components are presented in Table 2.

Box and whisker plots of the distribution of hs-cTnT: the bottom and top of the box represent the first and third quartiles (25th and 75th percentile), and the bold band inside the box is the second quartile (the median). The ends of the whiskers represent the lowest datum still within 1.5 the inter quartile range (IQR) of the lower quartile, and the highest datum still within 1.5 IQR of the upper quartile. The circles represent outliers in the range of 1.5 to 3 IQR and the stars represent extreme outliers, of more than 3 IQR.

Discussion

The main finding of the current study is the association of dysmetabolism with the eventual presence of chronic myocardial stress, expressed by elevated hs-cTnT concentrations in males with no known cardiovascular disease.

This is the first large report suggesting that the MetS is associated with elevated hs-cTnT concentrations in adult men. The findings are consistent with a previous work studying the relation of hs-cTnT and potential contributors for the metabolic health, one might accept that above association might raise a multiple-hit theory for the presence of that further stresses that need to calibrate threshold values based on similar factors are those patients the 99th percentile was 27.6 ng/l, being too limited to find out what is the main determinant for the components and according to the number of positive Mets components are presented in Table 2.

Hs-cTnT concentration was above the 99th percentile for almost 5% of patients with the MetS and for

Concentrations increased in relation to number of MetS components, which was statistically significant (p<0.001 for trend). In accordance with the finding of Wallace et al. of four predictors of elevated cTnT levels, one of which was diabetes mellitus [17] The above association might raise a multiple-hit theory for the presence of increased cTnT concentrations in apparently healthy individuals, meaning that MetS components may have an additive value in increasing hs-cTnT levels, a marker of myocardial stress. Despite of being too limited to find out what is the main determinant for the presence of enhanced cTnT concentrations in the peripheral blood, the results do point toward a multiple-hit possibility. Looking at the potential contributors for the metabolic health, one might accept that similar factors are those patients the 99th percentile was 27.6 ng/l, substantially higher than that determined by the manufacturer, at 14 ng/l. This finding is consistent with a previous work by Saunders et.al. [4] who found that actual 99th percentile concentrations were substantially higher than those determined by the manufacturer, a fact that further stresses that need to calibrate threshold values based on local empiric observations.

An additional significant finding of the present study is the association between multiplicities of dysmetabolic risk factors with absolute hs-cTnT concentrations. Although troponin levels were mildly lower in the group with 5 Mets components compared to those with 4 components, this group comprised of only 84 (5.1%) participants, thus the statistical significance of such minor variability could not be reliably analyzed. Therefore we determined the trend for hs-cTnT involved in the process of cardiomyocytes damage.

Limitations

Only male patients were included in the current analysis because most of the TAMCIS survey population consists of males, unfortunately we were under powered to include females in the study. In the statistical analysis we were unable to exclude factors closely related to the metabolic syndrome (e.g. hypertension, dyslipidemia and diabetes) or use a control group that would isolate their influence on troponin concentration without omitting major influences of the MetS itself. However, we examined patients with MetS as a group with multiple comorbidities by definition, thus an attempt to isolate one of its critical components seems not necessary.

Conclusion

Elevated concentrations of cTnT might be present in the peripheral blood of men with the metabolic syndrome. The association with multiplicity of dysmetabolic risk factors point toward the possibility of a multiple-hit mechanism that is involved in cardiomyocytes damage. No one dysmetabolic component could be singled out as the most dominant in this report, suggesting the need to improve most, if not all, of the dysmetabolic components in order to protect against cardiomyocytes damage.

References


