Non Invasive Predictors of Coronary Slow Flow

Ragab AbdelSalam Mahfouz, Mesbah Taha Hasanein, Elsayed Mohamad Farag, Radwa Mohamad Abdullah*
Cardiology Department, Faculty of Medicine, Zagazig University.

ABSTRACT

Background: The coronary slow flow phenomenon (CSFP) is an angiographic clinical entity, characterized by delayed distal vessel opacification in the absence of significant epicardial coronary stenosis. The pathogenic mechanisms are incompletely understood. It has direct clinical implications, being linked to clinical manifestations of myocardial ischemia, life-threatening arrhythmias, sudden cardiac death, and recurrent acute coronary syndrome.

Aim of the work: To evaluate the role of non-invasive measures in predicting Primary coronary slow flow patients.

Patients and methods: Our study was a case control study, taking patients referred for cardiac catheterization for suspected coronary artery disease. We took two groups 50 patients each. Group I: primary coronary slow flow phenomenon. Group II: normal coronary angiography. All patients were subjected to thorough clinical examination and full lab including lipid panel, hsCRP and Troponin, ECG where PWD and QTc dispersion were measured, TTE including coronary flow velocities (Diastolic and systolic) and DSPVR (Diastolic and systolic peak velocity ratio) as well as assessment of TIMI frame counts.

Results: The independent factors predicting PCSF among the examined groups, included diabetes, P wave dispersion ≥ 60 msec, QT dispersion ≥ 60 msec, HCT (hematocrit) level ≥ 40 % and hs CRP ≥ 4 mg/L and DSPVR ≤ 1.6. A score was done for the independent variables using the prediction equation for multiple regression. Patients with scores > 12 are more likely to have PCSF (P=0.000).

Conclusion: PCSF is associated with diabetes, greater PWD and QTc dispersion, higher HCT and hsCRP levels.

Key words: Primary coronary slow flow, Non invasive procedures.

INTRODUCTION

The coronary slow flow phenomenon (CSFP) is an angiographic clinical entity, characterized by delayed distal vessel opacification in the absence of significant epicardial coronary stenosis. (Wang X and Nie S, 2011)

The overall incidence of CSFP is 1% among patients who undergo coronary angiography, especially those presenting with acute coronary syndrome. (Chaudhry M. et al, 2012)

Several hypotheses of its mechanism including a form of early phase of atherosclerosis, microvessel dysfunction, Hagen-Poiseuille’s equation model, imbalance between vasoconstrictor and vasodilatory factors, and platelet function disorder were proposed. (Sadamatsu K et al, 2007).

This condition, which may affect one or all coronaries, was originally described by Tambe et al. in 1972. Since then it has been accepted as an independent clinical entity, which is called ‘CSFP’, ‘coronary slow flow syndrome’ ‘syndrome Y’, or “primary” coronary slow flow (Wang X and Nie S, 2011).

A number of case series have subsequently been published and have consistently shown the phenomenon to occur in a unique demographic group (Turner S, 2006). Patients with the CSFP are characterized by: Preponderance of middle aged males, Most have mixed pattern angina, Ongoing chest pain symptoms despite treatment with many undergoing repeat invasive and non invasive investigations (Turner S, 2006).

Despite good prognosis of CSFP patients, the subsequent progress is frequently characterized by remitting, relapsing anginal episodes resulting in considerable impairment in quality of life (Wang X and Nie S, 2011).

There is no definite treatment for patients with CSFP. Nitrates have been reported to be ineffective. By contrast dipyridamole seems to be effective in an acute setting during coronary angiography in patients with CSFP (Paul L et al, 2007).

There is no substantial data regarding the use of conventional calcium L-channel blockers such as amlodipine in patients with CSFP (Chaudhry M. et al, 2012).

Beltrame et al. assessed the acute and long-term clinical benefits of mibefradil in patients with CSFP. There was a significant acute angiographic improvement in coronary flow indices. Long term clinical benefits with mibefradil were also observed (Paul L et al, 2007).

AIM OF THE WORK

To evaluate the role of non-invasive measures in predicting Primary coronary slow flow patients.

PATIENTS AND METHODS

We conducted a case-control study using two groups: Group I: 50 patients with primary coronary slow flow phenomenon. Group II: 50 patients with normal coronary angiography.
study was done in Zagazig – University Hospitals’
catheterization laboratories during the period from
May 2011 to December 2013.

**Inclusion criteria:**
Patients referred for coronary angiography
because of suspected coronary artery disease.

**Exclusion criteria:**
Coronary artery stenosis, Coronary vasospasm,
Coronary ectasia, Uncontrolled hypertension and
severe LVH, Atrial fibrillation and cardiac rhythm
other than sinus, Angiography and stenting of acute
myocardial infarction, Heart failure and
cardiomyopathy, Valvular heart disease, Connective
tissue disease, Tachycardia, Anaemia and
thyrotoxicosis, Malignancy. Renal and hepatic
dysfunction. Acute and chronic infection. Current
use of anti-inflammatory drugs.

**All patients were subjected to:**
1- Request to sign a consent form.
2- Thorough history taking and physical
examination.
3- Height and weight were measured using a
standardized protocol. BMI (Body mass index) was
calculated by dividing weight in kilograms by
height in meters squared.
4- Laboratory parameters including were
collected from the patients after a 12 hours
overnight fasting and done at Zagazig University
hospitals clinical pathology laboratories:
  - Complete blood picture including mean platelet
    volume, white blood cell count and hematocrit
    using Sysmex KX 21 system.
  - HbA1c by Cobas 6000 plus system (Roche, USA)
    after an overnight fasting.
  - Complete lipid panel by Cobas Integra 400 plus
    system (Roche, USA).
  - Kidney function tests including serum creatinine by
    Cobas Integra 400 plus system (Roche, USA).
  - Cardiac troponin T by Cobas 6000 plus system
    (Roche, USA).
  - High sensitive CRP by Cobas Integra 400 plus
    system (Roche, USA).
5- Two 12 lead-ECGs were obtained for each
patient at rest: one standard and the second with 20
mm/mV amplitude and 50 mm/sec rate with
standard lead positions.

The ECGs were manually assessed measuring the
maximum P wave duration (the
beginning of the P wave was defined as the point
where the initial deflection of the p wave crossed
the isoelectric line, and the end of the P wave was
defined as the point where the final deflection of the
P wave crossed the isoelectric line), P wave
 dispersion (the difference between maximum and
minimum P wave duration) and QTc dispersion (the
difference between the longest (QTc max) and the
shortest (QTc min) QT intervals within a 12-lead
ECG) (Gunes Y et al, 2009).

6- Transthoracic echocardiography and color Doppler:
The echocardiographic examination was
performed at rest with a Kontron medical and a
Hewlett Packard (Sonos 5000) ultrasound units
using S3, S4 and S8 transducers.

Echocardiographic images were obtained
from the acoustic windows around MCL in the 4th
and 5th intercostal spaces in left lateral decubitus.
Left ventricle is adequately visualized in all
subjects. Once a two chamber view was obtained
the high frequency transducer was superimposed
over the same point on the thoracic surface, and a
modified foreshortened 2- Chamber view was
obtained by sliding the transducer superiorly and
medially.

The epicardial segment of the anterior wall
was focalized to find and best visualize the color-
coded blood flow in the anterior groove area. In
case of scarce visualization from the apical view, a
short axis view of the left ventricular apex and of
the anterior groove was obtained, trying to visualize
the coronary flow with color Doppler. Once a good
color-coded Doppler was obtained, pulsed wave
Doppler was attempted using a gate size set at 4.0
mm. attention was paid to maintain the angle
between the color flow and the Doppler beam below
20°.

Echocardiographic measurements:
a- Left ventricular end systolic and diastolic
dimensions (LVEDD, LVESD).
b- Left ventricular systolic function ( LVEF).
c- Left atrial diameter.
d- E, A and E/A ratio.
e- Coronary flow velocity: Diastolic and systolic
peak velocities and DSPVR was calculated.

7- Coronary angiography was performed in
Zagazig University Hospitals Catheterization
Laboratories (Cine angiographic equipment :Philips
Integris: cine frame: 30 fps). Selective coronary
angiography with standard multi-angulated
angiographic views was performed through the
femoral artery under local anesthesia (2%
Lidocaine) using the Judkins catheters and
iodopromide (Ultravist) as the contrast agent. The
angiograms were recorded on a compact disc in
DICOM format.
Coronary blood flow was measured quantitatively using the TIMI frame count which was derived from the number of cine-frames recorded from the first entrance of contrast to its arrival at the distal end of the left anterior descending artery, circumflex artery, or right coronary artery. The last frames used for the LAD, CX and RCA were those in which the dye first entered the mustache segment, the distal bifurcation segment and first branch of the posterolateral artery, respectively. The TIMI frame count of the LAD artery was corrected by dividing the final count by 1.7. The cut-off values were defined according to the TIMI frame count method of Gibson et al. (36±2.6 for LAD, 22.2±4.1 for CX, 20.4±3.0 for RCA).

Figure (1): Calculating TIMI frame counts. The first counting frame (frame 1) is the image where the contrast advances and fills at least 70% of the diameter of the arterial ostium. The last frame (final frame) is the image where the contrast begins to fill the final landmark. Distal bifurcations of the 3 epicardial arteries are shown. CD indicates right coronary artery; CX, circumflex artery; DA, left anterior descending coronary artery. (Gibson C et al, 2005)

Statistical analysis:

All statistical data were processed using the IBM SPSS 19 software. Data were expressed as mean±standard deviation (SD). Student t-test, and chi-square test were used to compare the variables. Correlations between the TIMI frame counts and other parameters were analyzed. A stepwise multivariate analysis was done for independent variables. Odds ratios and 95% confidence intervals were also calculated. A P value of less than 0.05 was considered significant. A PCSF score was done using the prediction equation for multiple regression.

RESULTS

Our study is a case control study. We took two groups: Group I: 50 patients with primary coronary slow flow (PCSF) and Group II: 50 Patients with normal Coronary angiography. Patients with PCSF phenomenon showed increased incidence of diabetes. (35 patients 70%) compared to (24 patients 48% in the control group, P = 0.025). As regards to smoking the number of smokers in the PCSF group were (30 patients 60%) compared to 11 patients in the control group, P <0.0001). Patients with PCSF had higher CCSA. Table (1).

Patients in the PCSF group had higher P max, P wave dispersion, QTc min and QTc dispersion compared to the control group with P values (0.01, 0.0001, 0.001 and 0.002 respectively). Regarding echo parameter PCSF group patients had greater LA diameter, and showed increased both diastolic and systolic peak flow velocities of the LAD compared to the control group with P values (0.03, 0.000 and 0.000 respectively). Yet regarding the DSPVR it was lower in patients with PCSF compared to the control group with very high statistical significant difference (P value = 0.000). Table (2).

Patients with PCSF had higher WBCs count, HCT, MPV and HsCRP compared to those in the control group, with very high statistical significant difference (P < 0.0001).
Table (1): Demographic data, risk factors and clinical data of both groups:

<table>
<thead>
<tr>
<th></th>
<th>PCSF 50 patients</th>
<th>Control 50 patients</th>
<th>Test</th>
<th>Test value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years (χ ±SD)</td>
<td>49.56 ± 7.8</td>
<td>52.3 ± 7.9</td>
<td>t</td>
<td>1.76</td>
<td>0.08</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M n (%)</td>
<td>34 (68%)</td>
<td>26 (52%)</td>
<td>χ²</td>
<td>2.67</td>
<td>0.1</td>
</tr>
<tr>
<td>F n (%)</td>
<td>16 (32%)</td>
<td>24 (48%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (χ ±SD)</td>
<td>30.48 ± 5.36</td>
<td>30.16 ± 3.2</td>
<td>t</td>
<td>0.36</td>
<td>0.71</td>
</tr>
<tr>
<td>HTN</td>
<td>21 (42%)</td>
<td>29 (58%)</td>
<td>χ²</td>
<td>2.56</td>
<td>0.11</td>
</tr>
<tr>
<td>DM</td>
<td>35 (70%)</td>
<td>24 (48%)</td>
<td>χ²</td>
<td>5</td>
<td>0.025*</td>
</tr>
<tr>
<td>Smoking</td>
<td>30 (60%)</td>
<td>11 (22%)</td>
<td>χ²</td>
<td>14.9</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td>HR bpm (χ ±SD)</td>
<td>76.04 ± 10.71</td>
<td>78.42 ± 10.4</td>
<td>t</td>
<td>1.12</td>
<td>0.26</td>
</tr>
<tr>
<td>SBP mmHg (χ ±SD)</td>
<td>121.6 ± 12.39</td>
<td>121.5 ± 13.4</td>
<td>t</td>
<td>0.04</td>
<td>0.96</td>
</tr>
<tr>
<td>DBP mmHg (χ ±SD)</td>
<td>78 ± 8.08</td>
<td>79.4 ± 9.67</td>
<td>t</td>
<td>0.7</td>
<td>0.43</td>
</tr>
</tbody>
</table>

CCSA

| N (%)                  |                  |                     |      |            |      |
| Class 2                | 11(22%)          | 20 (40%)            | χ²   | 23.25      | 0.052 |
| Class 3                | 20(40%)          | 30(60%)             |      |            |      |
| Class 4                | 19(38%)          | 0 (0%)              |      | <0.0001**  |      |

PCSF= Primary coronary slow flow; M= Male, F= female, BMI= body mass index, HTN= Hypertension, DM= diabetes, χ = mean, * statistically significant, **= very high statistical significance, HR= heart rate in beats per minute, SBP= systolic blood pressure, DBP= diastolic blood pressure, CCSA class= Canadian cardiovascular society class.

Figure (2): ROC curve for PWD showing sensitivity of 78 % and specificity of 70 % at a cut off value at 60 msec (AUC at 95% CI = 0.74(0.64-0.84))
Table (2): ECG and ECHO data of both groups:

<table>
<thead>
<tr>
<th></th>
<th>PCSF 50 patients</th>
<th>Control 50 patients</th>
<th>T test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P max msec (χ ±SD)</strong></td>
<td>124.04 ± 16.15</td>
<td>108.6 ± 27.18</td>
<td>3.45</td>
<td>0.01*</td>
</tr>
<tr>
<td><strong>P min msec (χ ±SD)</strong></td>
<td>62.4 ± 13.97</td>
<td>64.52 ± 20.04</td>
<td>0.6</td>
<td>0.54</td>
</tr>
<tr>
<td><strong>PWd msec (χ ±SD)</strong></td>
<td>59.44 ± 13.95</td>
<td>45.68 ± 17.34</td>
<td>4.37</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td><strong>QTc max msec (χ ±SD)</strong></td>
<td>467.28 ± 35.97</td>
<td>462.82 ± 24</td>
<td>0.73</td>
<td>0.46</td>
</tr>
<tr>
<td><strong>QTc min msec (χ ±SD)</strong></td>
<td>377.2 ± 31.69</td>
<td>397 ± 30.19</td>
<td>3.29</td>
<td>0.001**</td>
</tr>
<tr>
<td><strong>QTcd msec (χ ±SD)</strong></td>
<td>90.08 ± 39.82</td>
<td>67.92 ± 27.01</td>
<td>3.26</td>
<td>0.002*</td>
</tr>
<tr>
<td><strong>LVEDD in mm (χ ±SD)</strong></td>
<td>49.24 ± 4.28</td>
<td>48.9 ± 4.53</td>
<td>0.39</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>LVESD in mm (χ ±SD)</strong></td>
<td>27.54 ± 5.49</td>
<td>28.18 ± 4.62</td>
<td>0.63</td>
<td>0.53</td>
</tr>
<tr>
<td><strong>LVEF % (χ ±SD)</strong></td>
<td>68 ± 6.27</td>
<td>66.9 ± 7.22</td>
<td>0.8</td>
<td>0.41</td>
</tr>
<tr>
<td><strong>E/A ratio (χ ±SD)</strong></td>
<td>0.805 ± 0.1</td>
<td>0.78 ± 0.1</td>
<td>1.23</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>LA in mm (χ ±SD)</strong></td>
<td>36.46 ± 3.86</td>
<td>34.56 ± 4.95</td>
<td>2.14</td>
<td>0.03*</td>
</tr>
<tr>
<td><strong>SPV of LAD Mm/sec (χ ±SD)</strong></td>
<td>21.28 ± 4.3</td>
<td>41.68 ± 4.75</td>
<td>22.5</td>
<td>0.000**</td>
</tr>
<tr>
<td><strong>DPV of LAD Mm/sec (χ ±SD)</strong></td>
<td>41.34 ± 4.43</td>
<td>57.48 ± 5.55</td>
<td>16.1</td>
<td>0.000**</td>
</tr>
<tr>
<td><strong>DSPVR (χ ±SD)</strong></td>
<td>1.92±0.27</td>
<td>1.39±0.11</td>
<td>12.5</td>
<td>0.000**</td>
</tr>
</tbody>
</table>

PWd = P wave dispersion, QTc = corrected QT interval, QTcd = corrected QT dispersion, LVEDD: Left ventricular end diastolic dimension.

LVESD: Left ventricular end systolic dimension, LVEF: Left ventricular ejection fraction, SPV: systolic peak velocity, DPV: Diastolic peak velocity, DSPVR: Diastolic systolic peak velocity ratio.
Table (3): Laboratory data of both groups:

<table>
<thead>
<tr>
<th></th>
<th>PCSF 50 patients</th>
<th>Control 50 patients</th>
<th>T test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC (χ ±SD)</td>
<td>203.56 ± 31.56</td>
<td>200.12 ± 34.11</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>TG (χ ±SD)</td>
<td>100.4 ± 18.3</td>
<td>97.58 ± 14.66</td>
<td>0.85</td>
<td>0.39</td>
</tr>
<tr>
<td>LDL (χ ±SD)</td>
<td>137.86 ± 29.5</td>
<td>130.86 ± 22.39</td>
<td>1.34</td>
<td>0.18</td>
</tr>
<tr>
<td>HDL (χ ±SD)</td>
<td>42.34 ± 3.09</td>
<td>41.04 ± 3.73</td>
<td>1.89</td>
<td>0.61</td>
</tr>
<tr>
<td>WBC (χ ±SD)</td>
<td>8.84 ± 1.82</td>
<td>6.21 ± 1.32</td>
<td>8.27</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td>HGB (χ ±SD)</td>
<td>12.89 ± 0.78</td>
<td>12.65 ± 0.92</td>
<td>1.39</td>
<td>0.17</td>
</tr>
<tr>
<td>HCT (χ ±SD)</td>
<td>41.96 ± 3.8</td>
<td>39.48 ± 1.78</td>
<td>4.19</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td>PLT (χ ±SD)</td>
<td>260.78 ± 30.1</td>
<td>267.72 ± 44.96</td>
<td>0.9</td>
<td>0.36</td>
</tr>
<tr>
<td>MPV (χ ±SD)</td>
<td>9.91 ± 1.55</td>
<td>7.41 ± 0.5</td>
<td>10.8</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td>HsCRP (χ ±SD)</td>
<td>7.77 ± 1.89</td>
<td>3.56 ± 1.29</td>
<td>13.1</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td>S.Cr. (χ ±SD)</td>
<td>0.9 ± 0.156</td>
<td>0.914 ± 0.23</td>
<td>0.2</td>
<td>0.84</td>
</tr>
<tr>
<td>Tn (χ ±SD)</td>
<td>0.14 ± 0.35</td>
<td>0.01 ± 0.2</td>
<td>1.7</td>
<td>0.82</td>
</tr>
<tr>
<td>HbA1C (χ ±SD)</td>
<td>6.64 ± 1.43</td>
<td>6.05 ± 2.01</td>
<td>1.7</td>
<td>0.098</td>
</tr>
</tbody>
</table>

TC: Total cholesterol, TG: Triglycerides, LDL: Low density lipoprotein, HDL: High density lipoprotein, WBC: White blood cells.

TC: Total cholesterol, TG: Triglycerides, LDL: Low density lipoprotein, HDL: High density lipoprotein, WBC: White blood cells.

TC: Total cholesterol, TG: Triglycerides, LDL: Low density lipoprotein, HDL: High density lipoprotein, WBC: White blood cells.

S.Cr.: Serum creatinine, Tn: Troponin, HbA1C: Haemoglobin A1C.

Figure (3): ROC curve for QTcd showing sensitivity of 76% and specificity of 64% at a cut off value of 60 msec. (AUC at 95% CI = 0.68(0.57-0.78)).
Figure (4): ROC curve for DSPVR showing sensitivity of 78% and specificity of 92% at a cut off value of $\leq 1.6$ (AUC at 95% CI = 0.97 (0.95-1.0)).

Figure (5): ROC curve for HCT showing sensitivity of 82% and specificity of 46% at a cut off value of 40 (AUC at 95% CI = 0.73 (0.63-0.84)).

Figure (6): ROC curve for HsCRP showing sensitivity of 90% and specificity of 70% at a cut off value of 4 (AUC at 95% CI = 0.93 (0.88-0.98)).

**Stepwise multivariate analysis**

-596-
Table (4): Stepwise regression analysis of factors predicting PCSF

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>S.E.</th>
<th>Wald</th>
<th>P Value</th>
<th>Exp (B) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>2.6</td>
<td>1.03</td>
<td>6.29</td>
<td>0.01</td>
<td>13.46 (1.76-102.67)</td>
</tr>
<tr>
<td>PWD60</td>
<td>2.17</td>
<td>0.99</td>
<td>4.81</td>
<td>0.02</td>
<td>8.79 (1.26-61.38)</td>
</tr>
<tr>
<td>QTc60</td>
<td>2.922</td>
<td>1.0</td>
<td>8.54</td>
<td>0.003</td>
<td>18.5 (2.61-131.81)</td>
</tr>
<tr>
<td>HT40</td>
<td>3.188</td>
<td>1.118</td>
<td>8.12</td>
<td>0.004</td>
<td>24.24 (2.71-217.08)</td>
</tr>
<tr>
<td>hsCRP4</td>
<td>3.262</td>
<td>1.216</td>
<td>8.38</td>
<td>0.004</td>
<td>26.11 (2.87-237.4)</td>
</tr>
<tr>
<td>DSPVR ≤ 1.6</td>
<td>3.262</td>
<td>1.216</td>
<td>8.38</td>
<td>0.004</td>
<td>26.11 (2.87-237.4)</td>
</tr>
<tr>
<td>Constant</td>
<td>-9.809</td>
<td>2.51</td>
<td>15.24</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

OR= odds ratio. CI= Confidence interval.

Logistic regression analysis of factors predicting PCSF among the examined groups, included diabetes, P wave dispersion at 60 msec, QTc dispersion at 60 msec, hematocrit level at 40 % and hsCRP at 4 mg/L and DSPVR ≤ 1.6.

- Diabetic patients were 13.46 times at risk of having PCSF by angiography than non diabetics.

- Patients with P wave dispersion ≥ 60 msec were 8.79 times likely to have PCSF.

- Patients with QTc dispersion ≥ 60 msec were 18.5 times to have PCSF than those with lower levels of QTc dispersion.

- Patients with hematocrit level of ≥ 40 % were 24.24 times more prone to have PCSF by coronary angiography than those with lower levels.

- Patients with hsCRP ≥ 4 mg/ L were 7.5 times more likely to have PCSF by angiography than those with lower levels of hs CRP.

- Patients with DSPVR ≤1.6 were 26.11 times more likely to have PCSF by angiography than those with higher DSPV ratios.

Scoring for PCSF phenomenon was done using the independent variables.

Table (5): Scoring for PCSF phenomenon

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DM</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>PWD</td>
</tr>
<tr>
<td>&lt; 60 msec</td>
<td>1</td>
</tr>
<tr>
<td>≥ 60 msec</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>QTd</td>
</tr>
<tr>
<td>&lt; 60 msec</td>
<td>1</td>
</tr>
<tr>
<td>≥ 60 msec</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>HT</td>
</tr>
<tr>
<td>&lt;40</td>
<td>1</td>
</tr>
<tr>
<td>≥40</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>HsCRP</td>
</tr>
<tr>
<td>&lt; 4</td>
<td>1</td>
</tr>
<tr>
<td>≥ 4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>DSPVR</td>
</tr>
<tr>
<td>&gt; 1.6</td>
<td>1</td>
</tr>
<tr>
<td>≤ 1.6</td>
<td>2</td>
</tr>
</tbody>
</table>

The PCSF score was calculated for each individual using the independent variables by the prediction equation for multiple regression (Munro B, 2001):

\[ Y = \alpha + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6 \]

Where \( \alpha \) is the intercept constant and equals -9.405

B: is the seperable weight for each of the independent variables.
Non Invasive Predictors of Coronary Slow Flow

Scoring was done for each patient in both groups using the equation giving values ranging from 2.75 to 20.92. A cut off value $\geq 12$ was selected to identify patients with PCSF and ROC curve for that cut off value showed sensitivity of $96\%$, specificity of $70\%$.

**Table (6): The validity of cut off value of $\geq 12$ in prediction of PCSFP**

<table>
<thead>
<tr>
<th>T+</th>
<th>T-</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>PPV</th>
<th>NPV</th>
<th>Kappa</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score $\geq 12$</td>
<td>48</td>
<td>35</td>
<td>96</td>
<td>70</td>
<td>76.2</td>
<td>94.6</td>
<td>0.66</td>
</tr>
</tbody>
</table>

**DISCUSSION**

In our study, there was no statistical difference between the two groups regarding the age, the gender, the BMI, and hypertension. This was in agreement with *(Hasan A et al, 2010)* and disagree with *(Hawkins B et al, 2011)* where they found patients with PCSF were more males and had higher BMI, this might be contributed to the nature of the population studied with certain differences between the Japanese people and the Egyptians. This also disagree with *(Gunes Y et al, 2011)* where they found patients with PCSF had higher BMI this might be due to increased the incidence of obesity in the Egyptians.

Regarding smoking, in our study PCSF phenomenon was more common in smokers with high statistical significant difference, this was in agreement with *(Selcuk H et al, 2009)* and disagree with *(Gunes Y et al, 2009)* and *(Nurkalem Z et al, 2008)* this might be because of all of those studies were conducted in Turkey which previously was a country with the highest smoking rates in the world till 2009 *(The conservative media, 2009)*.

In our study, there was no statistical difference between both groups regarding the heart rate and blood pressure (systolic and diastolic) this was in agreement with *(Selcuk H et al, 2009)*, *(Hasan A et al, 2010)* this might be due to the adequate treatment given to those patients controlling their heart rates and blood pressure.

Regarding the Canadian cardiovascular society class angina, those patients with PCSF in our study presented with higher classes this might show the aggressive nature and course of PCSF phenomenon.

In our study, the PCSF group had higher $P_{\max}$, $P$ wave dispersion compared to the control group with significant statistical difference. These was in agreement with *(Gunes Y et al, 2009)* and...
(Mahmoud K, 2013) this might be due to altered cardiac autonomic nervous control with reduced vagal tone and a shift toward sympathetic predominance in microvessel disease.

Also patients with PCSF in our study had higher QTc min and QTc dispersion compared to the control group with significant statistical difference. This was in agreement with (Atak R et al, 2003) and (Mahmoud K, 2013).

QT interval dispersion reflects regional variations in ventricular repolarization and cardiac electrical instability. Previous studies have showed that QT interval dispersion changes during episodes of myocardial ischemia. Ischemia in microvascular level and/or altered autonomic regulation of the heart may be responsible. (Sezgin A et al, 2007).

Regarding the echo data in our study there was no statistical significant difference concerning LVEDD, LVESD, EF, E/A ratio. These results disagreed with (Gunes Y et al, 2009) which show significant decrease in E/A ratio. This might be explained that most of our patients showed impaired diastolic function may be due to the prevalent obesity, hypertension among both groups.

PCSF group patients had greater LA diameter compared to the control group yet its still within the normal limits. They also showed decreased both diastolic and systolic peak flow velocities of the LAD compared to the control group with P values (0.03, 0.000 and 0.000 respectively). DSPVR was lower in patients with PCSF compared to the control group with very high statistical significant difference (P value = 0.000) This was in agreement with (Nie S and Wang x, 2010) where the PCSF phenomenon had significantly lower DPV and SPV.

There was no statistical significant difference regarding the lipid panel in either groups. This was in agreement with (Hasan A et al, 2010) and (Gunes Y et al, 2011). And disagree with (Tanriverdi H et al, 2010) this might be due to the increased BMI in both groups in our study with abnormal lipid panels in both.

In our study, patients with PCSF had higher levels of WBCs, HCT and MPV compared to patients in the control group. This was in agreement with (Nurkalem Z et al, 2008) which showed higher MPV in PCSF group and (Yaron A et al, 2009) which showed higher HCT level in PCSF group. Both indicate increased blood viscosity in those patients with PCSF phenomenon. It is known that platelets having dense granules are more active biochemically, functionally and metabolically and are a risk factor for developing coronary thrombosis (Nurkalem Z, 2008). Large platelets secrete high levels of prothrombogenic thromboxane A2, serotonin, beta thromboglobulin, and procoagulant membrane proteins like P-selectin and glycoprotein IIIa. In addition they are less sensitive to inhibitory effects of prostacycline on aggregation and secretion than small platelets. (Nurkalem Z, 2008)

Patients with PCSF had higher levels of HsCRP compared to the control group. This was in agreement with (Madak N et al, 2010) and (Jianjun L et al, 2007) which showed increased levels of HsCRP in patients with PCSF pointing to the contribution of HsCRP as an inflammatory marker to the atherosclerotic process. That’s why all patients with inflammatory diseases were excluded from our study for HsCRP to be valid as a marker for atherosclerotic process.

Regarding the troponin level, no statistical difference was found between the two groups. Perhaps because of the paucity of cases with elevated troponin making it unreliable for measuring a statistical significance.

Concerning the HbA1C. in our study, there was not statistical significant difference between both groups. This was in agreement with (Yaron A et al, 2007) and disagree with (Yilmaz M et al, 2010) where the whole population studied were mainly type 2 diabetics.

The PCSF score was calculated for each individual using the independent variables by the prediction equation for multiple regression (Munro B, 2001).Scoring was done for each patient in both groups using the equation giving values ranging from 2.75 to 20.92. A cut off value ≥ 12 was selected to identify patients with PCSF and ROC curve for that cut off value showed sensitivity of 96%, specificity of 70% (P < 0.000). We didn’t have a comparative score in the literature to validate ours, making it a new aid in predicting PCSF phenomenon where it sums up the independent non invasive variables in a figure making it easy to predict PCSF patients.

Conclusion: PCSF is associated with diabetes, greater PWD and QTc dispersion, higher HCT and HsCRP levels. The PCSF score done in our study will give an aid in predicting and PCSF patients and will help in follow up and treatment monitoring.

REFERENCES

1. Atak R, Turhan H and sezgin A. Effects of coronary slow flow on QT interval and
Non Invasive Predictors of Coronary Slow Flow


