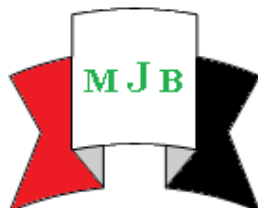


## Echocardiographic Estimation of Infarct Size By Using Cardiac Biomarkers (Troponin I,CK And CK-MB) And Some Hematological Changes in Patients With STEMI

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**Received 30 March 2014**

**Accepted 20 April 2014**

### **Abstract**

**Background:** Severity of infarction in ST segment elevation MI (STEMI) is clinically important so early determination of infarct size by using non- invasive ,non-coasty imaging modalities is a key to assessing the future risk of patients and instructive for optimization of therapeutic strategies.

**Aims of the study:** 1-To evaluate the efficacy of echocardiographic examination in estimation of extension and severity of infarction in ST segment elevation MI (STEMI) and its relationship with cardiac biomarkers and some hematological changes.2-To find out the relationship between these biomarkers and post STEMI complications .

**Materials & Methods:** The study lasted from 23th / October/2012 to 28th / May / 2013 in AL-Zahraa teaching hospital in Kerbala city There are 92 ( $56 \pm 13$  years old) patients and 86 ( $50 \pm 12$  years old) healthy controls are taken in this study. ECG and echocardiographic study of wall motion abnormality had been done for each one as well as serum cardiac biomarkers as cardiac troponin I (cTRI) , Creatine kinase (CK) and creatine kinase myocardial band (CKMB) also hematological analysis (WBC,ESR & platelet count) . The patients are classified into 3 groups (G1,G2 &G3) according to wall motion score index (WMSI): G1 WMSI ( $>2$ ) MI ; G2 WMSI ( $1.7-2$ ) and G3 WMSI ( $<1.7$ ) to estimate the extension of myocardial injury .

**Results:** Cardiac biomarkers study , serum cTRI ; CK and CK-MB showed that there was high significant increment in relation to severity of infarction ( $p<0.01$ ) assessed by WMSI . Our result revealed that there was strong relationship between both serum cTRI and CK-MB concentration and acute complications developed in ST-elevation MI ,statistically reaching ( $P<0.01$ ) and ( $p<0.05$ ) respectively. Hematological showed highly significant ( $p<0.01$ ) increase in the levels of platelet count according to the severity of infarction (G 1,G2 and G 3) while the total white blood cells (WBC)count and erythrocyte sedimentation rate (ESR) showed significant ( $p<0.01$ ) increment in group 1 and group 3 only.

**Conclusion:** In patients with STEMI echocardiographic examination of left ventricle wall motion abnormalities and calculate WMSI reveal good estimation of severity and extension of infarction which is assessed by increment of cardiac biomarkers ,presence of acute complications as arrhythmias which is associated with increase in serum biomarker concentration give us a clue about adverse prognosis of MI.

استخدام فحص الايكو لاستتباط حجم الجلطة القلبية باستخدام الكيمياويات المؤشرة و بعض التغيرات الدموية

لمرضى الجلطة نوع STEMI

## الخلاصة:

تعتبر خطورة احتشاء عضلة القلب نوع (ستيمي) ذات أهمية سريرية عالية لذلك يكون الكشف المبكر لحجم الاحتشاء باستخدام الوسائل الغير مخترقة والغير مكلفة هي المفتاح لتقييم الخطورة المستقبلية لهؤلاء المرضى والوصف لستراتيجيات الشفاء و تهدف هذه الدراسة الى تقييم فعالية فحص القلب بالأموح فوق الصوتية (الإيكو) في استنتاج امتداد و شدة احتشاء عضلة القلب و علاقتها مع الكيموجويات القلبية وكذلك مع بعض التغيرات الدموية.

استغرقت مدة الدراسة من بداية شهر تشرين الأول 2012 ولغاية نهاية ايار ٢٠١٣ و إشتملت على ٩٢ مريضاً باحتشاء عضلة القلب و ٨٦ ممن هم اصحاء كمجموعة سيطرة. وقد اجريت الدراسة على المرضى الذين راجعوا مستشفى الزهراء التعليمي في مدينة كربلاء المقدسة وادخلوا الى وحدة الانعاش. وقد خضع المرضى لفحص تخطيط القلب الكهربائي (ECG) و فحص القلب بالأموح فوق الصوتية (الإيكو) لكل مريض بالإضافة الى المتغيرات الكيموجوية القلبية كتحليل التروبونين ابي (cTRI) و الكرياتين كينيز (CK) وكذلك تحليل و الكرياتين كينيز نوع الرابط القلبي (CKMB). بعض التحاليل لمباحث الدم. تم تصنيف مرضى هذه الدراسة الى ثلاث مجاميع وذلك حسب مؤشر الحركة الشاذة لجدار البطين الايسر: المجموعة الاولى (اكثر من ٢) والمجموعة الثانية (من ١.٧ الى ٢) والمجموعة الثالثة (اقل من ١.٧).

أظهرت نتائج تحليل المؤشرات الكيموجوية القلبية ل (cTRI) , (CK) , (CKMB) في مصل دم المرضى زيادة معنوية عالية ( $P<0.01$ ) لكل منهم مقارنة بحجم الاحتشاء لدى المرضى المصابين بالجلطة القلبية و كذلك بالمقارنة مع المجموعة القياسية. نتائج اخرى لهذه الدراسة اثبتت بان هنالك علاقة معنوية عالية بين تركيز كلا من (cTRI) و (CK-MB) و تطور المضاعفات الجانبية لمرضى الجلطة القلبية نوع (STEMI). بالنسبة لبعض فحوصات معايير الدم للمرضى أظهرت الدراسة زيادة معنوية عالية في مستوى الصفائح الدموية ( $P<0.01$ ) في الدم بالمقارنة مع حجم الاحتشاء بين المجموعة الاولى و الثانية و الثالثة و كذلك مع مجموعة السيطرة. بينما كان لمستوى كريات الدم البيضاء و معدل ترسيب الكريات الحمراء زيادة معنوية عالية فقط بين المجموعة الاولى و الثالثة.

## Introduction :

**A**cute myocardial infarction (MI) remains a leading cause of morbidity and mortality worldwide. Myocardial infarction (MI) is the death of myocardial cells that occurs following prolonged oxygen deprivation [1]. Myocardial cells begin to die after about 20 minutes of oxygen deprivation [2].

Two main types of acute AMI are identified : ischemic symptoms that develop ST elevation in two contiguous leads called an 'ST elevation MI' (STEMI) ,when the acute ischemia is transmural. Patients without ST elevation at presentation are usually designated as having a 'non-ST elevation MI' (NSTEMI) when ischemia confined primarily to the subendocardium[3].

Myocardial injury is detected when blood levels of biomarkers such as cardiac troponin I (cTnI) or the

myocardial band fraction of creatine kinase (CK-MB) are increased .Cardiac troponin I is components of the contractile apparatus of myocardial cells and are expressed almost exclusively in the heart. these biomarkers in the blood reflect injury leading to necrosis of myocardial cells, they do not indicate the underlying mechanism [4].

In the overall care of ST-segment elevation myocardial infarction (STEMI) patients measurement of infarct size is an important issue, since the extent of infarction bears a direct relationship to prognosis, and guides both short and long-term therapeutic decisions [5].The cardiac biomarkers allowing the physician to track the extent of injury suffered by the myocardium [6] as well as echocardiography is an important tool for assessment of acute MI because of their ability to detect wall motion abnormalities or loss of viable myocardium in the presence

of elevated cardiac biomarker values [7] so both of them can provide measurement of infarct size which is a primary determinant of prognosis in these patients [8].

### **Materials and Methods:**

This prospective study lasted from 23<sup>th</sup> / October/2012 to 28<sup>th</sup> / May / 2013 at cardiac care unit (CCU) ward in AL-Zahraa teaching hospital in Kerbala City. Sample of study was 178 (92 patients & 86 healthy control) with age (37-94) years. They

These groups included patients with acute myocardial infarction (MI) type S-T elevation on ECG& undergo antithrombotic therapy on admission,during 12 to24 hours from the starting of chest pain serum send for cardiac biomarkers analysis (cTnI,CK &CK-MB) [9,10] and blood for hematological study (WBC,ESR &Platelet count) .Patients were classified according to the echocardiographic examination of left ventricle wall motion and according to wall motion score index (WMSI) into: Group (1),patients with  $>2$  (WMSI) (14 male &8 female, total 22) . Group (2), patients with 1.7- 2 (WMSI) (23 male & 19 female, total 42) and Group (3) , patients with (WMSI)  $<1.7$  (13 male & 15 female, total 28). The healthy subjects group was with negative medical history, no smoking, free from any illness or any factor that leading to increase of any cardiac biomarker .

### **Wall Motion Score Index (WMSI):**

The LV can be divided into 17 anatomic segments, which can be viewed as a composite from the standard echocardiographic views, and have standardized nomenclature as recommended by the American Heart Association (AHA) [11].For each segment, the findings should

be confirmed in multiple views and a score should be assigned, such as: [11,12].

1-normal,2-hypokinesis, (thickening, but less than normal).3-akinesis, (no thickening).4-dyskinesis, and 5-aneurysmal. (no thickening, with outward movement of the segment during systole .

Thus, the higher the score, the worse are the wall motion abnormalities. A wall motion score index (WMSI) can be derived by dividing the sum of the individual score by the number of segments analyzed. A WMSI of 1.7 or more usually suggests a defect greater than 20% of LV in patients after MI [12]. Nearly 95% of segments with  $>25\%$  scar had  $\geq 2$  wall motion score abnormality. .

### **Statistical Analysis:**

SPSS program was used in this study. All values were expressed as mean  $\pm$  standard deviation (SD) or number (percentage). One way ANOVA was used to estimate differences between groups. The differences were considered significant when the probability (P) was less than 0.05( $P < 0.05$ ) and highly significant when the probability (P)was less than 0.01( $P < 0.01$ ) .

### **Results:**

#### **Cardiac Biomarkers result**

Table (1) :In G1 with high WMSI infarct patients sera concentration which represent 12.2 fold of that in control group and 8.3 folds of that in G2 and only 4.8 folds for low WMSI infarct patient(G3), these values which illustrated in table (1) showed that there was a highly significant( $p < 0.01$ ) increase in serum troponin I among STEMI patients groups.

**Table (1)** Cardiac Troponin I concentration in patients with STEMI groups and control.

|                                  |                                         | Troponin I in (ng/ml)          |                                |
|----------------------------------|-----------------------------------------|--------------------------------|--------------------------------|
|                                  |                                         | Male                           | Female                         |
| <b>STEMI</b>                     | <b>Group 1</b><br><b>WMSI (&gt;2)</b>   | <b>5.21±0.85</b><br><b>(A)</b> | <b>4.73±1.05</b><br><b>(A)</b> |
|                                  | <b>Group 2</b><br><b>WMSI (1.7-2)</b>   | <b>2.90±0.86</b><br><b>(B)</b> | <b>2.85±0.52</b><br><b>(B)</b> |
|                                  | <b>Group 3</b><br><b>WMSI (&lt;1.7)</b> | <b>1.72±0.53</b><br><b>(C)</b> | <b>1.41±0.48</b><br><b>(C)</b> |
| <b>Healthy subjects(control)</b> |                                         | <b>0.36±0.25</b><br><b>(D)</b> | <b>0.27±0.20</b><br><b>(D)</b> |

-STEMI:ST elevation myocardial infarction. WMSI:wall motion score index.  
 - V a l u e s a r e m e a n ± S D  
 -The values with different capital letter mean significant at 0.01 level.

Table (2) :There was highly significant (p<0.01) increase in mean serum CK of patients sera as compared with healthy control group for male and also

for female .Also there was highly significant(P<0.01) difference between each of patient groups(1,2 and 3).

**Table (2)** Creatine Kinase (CK) concentration in patients with STEMI groups and control.

|  |  | CK in<br>(IU/L) |        |
|--|--|-----------------|--------|
|  |  | Male            | Female |

| <b>STEMI</b>                     |                       |                     |                     |
|----------------------------------|-----------------------|---------------------|---------------------|
|                                  | <b>Group 1</b>        | <b>467.42±96.12</b> | <b>480.50±63.61</b> |
|                                  | <b>WMSI (&gt;2)</b>   | <b>(A)</b>          | <b>(A)</b>          |
|                                  | <b>Group 2</b>        | <b>347.57±43.98</b> | <b>365.05±13.51</b> |
|                                  | <b>WMSI (1.7-2)</b>   | <b>(B)</b>          | <b>(B)</b>          |
|                                  | <b>Group 3</b>        | <b>270.07±42.55</b> | <b>268.67±32.74</b> |
|                                  | <b>WMSI (&lt;1.7)</b> | <b>(C)</b>          | <b>(C)</b>          |
| <b>Healthy subjects(control)</b> |                       | <b>125.04±29.17</b> | <b>123.99±30.67</b> |
|                                  |                       | <b>(D)</b>          | <b>(D)</b>          |

-The values with different capital letter regarding patient & control groups mean significant at 0.01 level.

Table (3) :Showed that there was a significant increase (p<0.01) in serum CK-MB level among STEMI

patient groups in compared with healthy control ,female groups had the same result at (p<0.01).

**Table (3):**Creatine Kinase –MB concentration in patients with STEMI groups and control.

|              |                     | <b>CK-MB in</b>   |                   |
|--------------|---------------------|-------------------|-------------------|
|              |                     | <b>(IU/L)</b>     |                   |
|              |                     | <b>Male</b>       | <b>Female</b>     |
| <b>STEMI</b> | <b>Group 1</b>      | <b>83.50±6.61</b> | <b>84.55±9.81</b> |
|              | <b>WMSI (&gt;2)</b> | <b>(A)</b>        | <b>(A)</b>        |
|              | <b>Group 2</b>      | <b>61.43±6.46</b> | <b>61.07±6.38</b> |
|              | <b>WMSI (1.7-2)</b> | <b>(B)</b>        | <b>(B)</b>        |

|                                  |                       |                   |                   |
|----------------------------------|-----------------------|-------------------|-------------------|
|                                  |                       |                   |                   |
|                                  | <b>Group 3</b>        | <b>41.62±8.41</b> | <b>42.34±7.05</b> |
|                                  | <b>WMSI (&lt;1.7)</b> | <b>(C)</b>        | <b>(C)</b>        |
| <b>Healthy subjects(control)</b> |                       | <b>14.57±5.27</b> | <b>14.75±5.27</b> |
|                                  |                       | <b>(D)</b>        | <b>(D)</b>        |

-The values with different capital letter regarding patient & control groups mean significant at 0.01 level.

Table(4) Our data revealed that there was statistically strong relationship (P<0.01) between serum troponin I and

CK-MB concentration and acute complications developed in STE MI

**Table(4):**Cardiac Biomarkers concentration with acute complications development in patients with STE MI.

|                                     | <b>Cardiac biomarkers</b> |                   |                     |                    |
|-------------------------------------|---------------------------|-------------------|---------------------|--------------------|
|                                     |                           | <b>Troponin I</b> | <b>CK</b>           | <b>CK-MB</b>       |
|                                     |                           | <b>(ng/ml)</b>    | <b>(IU/L)</b>       | <b>(IU/L)</b>      |
|                                     | <b>Yes</b>                | <b>4.37±1.30</b>  | <b>410.42±64.45</b> | <b>50.23±11.10</b> |
| <b>Acute complications of STEMI</b> | <b>no</b>                 | <b>2.78±1.35</b>  | <b>380.61±92.05</b> | <b>62.50±15.04</b> |
|                                     | <b>P value</b>            | <b>P&lt;0.01</b>  | <b>P&gt;0.05</b>    | <b>P&lt;0.05</b>   |
|                                     |                           |                   |                     |                    |

### Some hematological results:

Table(4): reveals a highly significant increase in WBC count for both of the male and female patients groups (G1,G2 and G3) in comparison with the male and female healthy control (  $p < 0.01$ ).ESR shows a highly significant ( $p < 0.01$ ) increase in both of male and female patients group

in relation with the male and female healthy control groups .Also pointed out that there was highly significant difference in ESR between each patient groups (  $p < 0.01$ ) .According to platelet count also there was a highly significant difference in platelet count between each patient groups (  $p < 0.01$ ) as well as with the control group.

**Table (5) Total White Blood Cells (WBC): Erythrocyte Sedimentation Rate (ESR)%&Platelet count distribution of patients with STE MI and control group.**

|                                    | WBCs( $\times 10^3/\mu\text{l}$ ) |                                  | ESR mm/hr                         |                                   | Platelet ( $\times 10^3/\mu\text{l}$ ) |                                |
|------------------------------------|-----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|----------------------------------------|--------------------------------|
|                                    | Male                              | Female                           | Male                              | Female                            | Male                                   | Female                         |
| <b>Group 1</b>                     | <b>14.49<math>\pm</math>1.57</b>  | <b>13.50<math>\pm</math>1.70</b> | <b>37.86<math>\pm</math>16.90</b> | <b>31.13<math>\pm</math>14.18</b> | <b>269<math>\pm</math>71.6</b>         | <b>301<math>\pm</math>61.3</b> |
| <b>WMSI (<math>&gt;2</math>)</b>   | <b>(A)</b>                        | <b>(A)</b>                       | <b>(A)</b>                        | <b>(A)</b>                        | <b>(A)</b>                             | <b>(A)</b>                     |
| <b>Group 2</b>                     | <b>12.33<math>\pm</math>1.45</b>  | <b>11.91<math>\pm</math>2.24</b> | <b>19.48<math>\pm</math>8.36</b>  | <b>21.19<math>\pm</math>5.70</b>  | <b>238<math>\pm</math>43.7</b>         | <b>251<math>\pm</math>45.9</b> |
| <b>WMSI (1.7-2)</b>                | <b>(B)</b>                        | <b>(B)</b>                       | <b>(A)</b>                        | <b>(A)</b>                        | <b>(B)</b>                             | <b>(B)</b>                     |
| <b>Group 3</b>                     | <b>9.12<math>\pm</math>1.85</b>   | <b>10.84<math>\pm</math>1.91</b> | <b>15.54<math>\pm</math>7.51</b>  | <b>19.93<math>\pm</math>6.67</b>  | <b>182<math>\pm</math>35.4</b>         | <b>162<math>\pm</math>12.8</b> |
| <b>WMSI (<math>&lt;1.7</math>)</b> | <b>(C)</b>                        | <b>(CB)</b>                      | <b>(B)</b>                        | <b>(B)</b>                        | <b>(C)</b>                             | <b>(C)</b>                     |
| <b>Healthy subjects(control)</b>   | <b>6.11<math>\pm</math>1.24</b>   | <b>6.29<math>\pm</math>1.28</b>  | <b>5.93<math>\pm</math>1.16</b>   | <b>6.72<math>\pm</math>1.30</b>   | <b>202<math>\pm</math>54.2</b>         | <b>172<math>\pm</math>17.9</b> |
|                                    | <b>(D)</b>                        | <b>(D)</b>                       | <b>(C)</b>                        | <b>(C)</b>                        | <b>(D)</b>                             | <b>(C)</b>                     |

-Values are mean  $\pm$  SD

-The values with different capital letter mean significant at 0.01 level.

- The values with same capital letter means no significant ( $p > 0.05$  ).

## **Discussion:**

### **Cardiac Biomarkers and extent of MI:**

Serum cardiac troponin I (cTRI) values had showed a highly significant increment in both male and female STEMI patients (Table 1) which is strongly related to the extent of MI injury estimated by WMSI. This result agree with other studies [13,14]. Study by Ohlmann, *et al.*, (2003) [15] suggest that cTRI study is a reliable tool for predicting large enzymatic infarct size and may help in selecting patients with a high risk. Other authors have also found a strong correlation of troponin I with the extent of myocardial damage even after 72 hours and 5 days [16-17]. The explanation of this finding is that cTnI is a cardiac-specific protein, which rapidly increases after AMI by a release of a loosely bound pool, due to degradation of myofilaments in the area of infarction so more infarct tissue result in more cardiac troponin release [18].

From (table 2) result shows that mean serum CK values of high WMSI patients were highly significant increase than those of low WMSI group, these results agree with the result of [16,19] whom found a significant correlation was observed between CK estimate and infarct size.

Results of CK-MB concentrations, as shown in table (3) revealed that there was a highly significant difference increment between patient groups according to the WMSI these results consistent in data reported by [13,17].

So in contrast to what was stated above a significant positive quantitative correlations between peak serum myocardial enzyme with the extent of myocardial damage and MI severity [20] and the quantity of

cardiac markers released correlates with infarct size thus provide a good assessment of WMSI for detecting the extent of myocardial damage.

### **Cardiac biomarkers and acute complications:**

Acute complications were found in 12% of patients in this study mostly with arrhythmia (Atrial fibrillation, ventricular tachycardia) which was 9% and Cardiogenic shock 3% this result agrees with [21]. Resulted data in table (5) showed that there was a high significant increase in serum cTRI in complicated patients, and only significant increase in serum CK-MB this results in a good agreement with results of the other researchers [22] who mentioned that larger infarct size, as estimated by peak serum CK-MB concentration, is significantly associated with VT/VF as well as other adverse clinical outcomes. This is probably due to a high sensitivity of cardiac troponins than CK-MB to cardiac myonecrosis.

About CK biomarker concentration in our result also shows increment but not reach significant relationship with incidence of acute complication in STEMI patients, this result is in agree with [23] this result perhaps due to non-specificity of CK to the cardiac tissue

### **Some hematological parameters and extent of MI:**

Table (5) demonstrated that the values of WBC count on admission was highly significant ( $p < 0.01$ ) increased in both male and female MI patients group in association with their severity of infarction; as well as when compared with control group. This result agrees with (Hochman, 2003 and Cecchi *et al.*, 2009). Other author [24] mentions that WBC count associated with high mortality rate in STEMI patients and may be

attributed to the size of infarction . Elevation in WBC count was associated with reduced epicardial blood flow and myocardial perfusion, thromboresistance and a higher incidence of new congestive heart failure and death. These observations provide a potential explanation for the higher mortality rate observed among STEMI patients with elevated WBC counts and helps to explain the links of inflammation and cardiovascular disease and its relation with infarct size [24].

The values of ESR as was shown in Table (5) reflected a highly significant ( $p<0.01$ ) increment in extensive MI compared to the other groups this agrees with [25]. Significant and independent association between blood viscosity and infarct size in STEMI patients suggesting that blood viscosity, in a condition of low flow, might worsen myocardial perfusion leading to an increased infarct size on the other hand inflammation also can induce endothelial dysfunction in small vessels, resulting in an impaired coronary flow. In contrast to what was stated above that raised ESR is of great value as a screening test of MI extension [26,27].

Experimental animal and clinical studies indicate that blood platelets have an important role in atherosclerosis and formation of thrombi [28]. Our result of platelets counts; Table (5) showed a highly significant increase in platelet count in both male and female patient groups compared to the control group as well as between patient groups , when compared with previous studies [29,30] shows a good agreement ,this result gives us a clue of importance of measuring platelet count and it is relation with severity of disease,. A possible explanation is that increased platelet

concentration may be a factor that propagates the conversion of a relatively mild thrombotic process into an aggressive and more extensive one [31].

### **Conclusions:**

- 1.The echocardiographic assessment of wall motion score index (WMSI) for STEMI patients shows a significant estimation for extent of infarction by using cardiac biomarkers (cTRI ,CK and CK-MB) .
2. There are strong association of each one of increasing WBC count ,platelet count and ESR with the extent of infarction .
3. Cardiac biomarkers are strongly increased in STEMI patients sera who having an acute complications as arrhythmias and hypotension .

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