

ORIGINAL ARTICLE

UTILITY OF HEART TYPE FATTY ACID BINDING PROTEIN (H-FABP) POINT OF CARE TEST IN THE EARLY HOURS OF STEMI COMPARED WITH TROPONIN-I IN PAKISTANI POPULATION

Walid Ahmad Abbasi, Muhammad Saleem, Shahid Rasheed, Azhar Mahmood Kiyani

Rawalpindi Institute of Cardiology, Rawalpindi-Pakistan

Background: Acute coronary syndrome remains a dominant cause of high morbidity and mortality despite advancements in treatment. This study was conducted to examine the utility of point-of-care test of heart-type fatty-acid binding protein (h-FABP) and compare it with the point-of-care test of cardiac troponin I (cTnI) in the first 06 hours of STEMI. **Methods:** This cross-sectional, comparative study which was conducted in Rawalpindi institute of cardiology, Rawalpindi, Pakistan, from January to June 2015. Serum samples of 125 patients with the diagnosis of STEMI, presenting with chest pain of less than 6 hours' duration, were analysed for quantitative and qualitative determination of h-FABP and cardiac troponin I (cTnI) using rapid immunochromatographic technique in the emergency department. Samples were taken at presentation and after 12 hours. **Results:** Out of 125 patients, 112 were males and 13 were females with a mean age of 54.26 ± 9.53 years. The average symptom-to-sample time was 3.19 ± 1.44 hours (median 3 hours). Mean h-FABP levels were significantly higher than the mean cTnI levels (29.10 ± 30.66 vs 0.94 ± 2.02 ; $p=0.000$). Overall, H-FABP was more sensitive than cTnI (72% vs 26.4%). The sensitivity of cTnI within 0–2, 2–4, and 4–6 hours of symptom onset was calculated to be 0%, 17.7%, and 75.9%, whereas sensitivity of H-FABP was 35.3%, 79.03% and 100% respectively. There was not a single patient who was cTnI positive and H-FABP negative as compared to 57 patients who were FABP positive and cTnI negative. **Conclusion:** h-FABP is a promising cardiac biomarker for the early identification of myocardial ischemia and infarction. It could be a superior biomarker for earlier detection of ACS and screening of patients with non-cardiac chest pain.

Keywords: Heart type fatty acid protein; ST-segment elevation myocardial infarction; Troponin I, STEMI

J Ayub Med Coll Abbottabad 2017;29(1):107–11

INTRODUCTION

Acute coronary syndrome remains a dominant cause of high morbidity and mortality despite advancements in treatment and poses high economic burden.¹ Both NSTEMI and STEMI share similar long term prognosis, whereas STEMI is associated with worst short term prognosis.² Extensive work has been done to minimize the delays in the diagnosis and treatment of STEMI which has led to the invention of standard parameters like door to needle and door to balloon times. Early identification and initiation of treatment of STEMI not only helps reduce infarct size but also promises good prognosis and better quality of life. Cardiac troponins are gold standard used extensively and reliably for the in-hospital diagnosis and exclusion of STEMI with certain limitations. Cardiac troponin is a high molecular weight protein (21–37 KDa) and because of its larger size can usually be detected after 4–6 hrs of myocardial injury and may require repeated measurements (8–12 hourly). These features could be responsible for unnecessary delays in the diagnosis and management of myocardial infarction.^{3,4,8}

Numerous biomarkers have been studied in the past to assist in the earlier diagnosis of STEMI in addition to troponins especially in the window period

of initial 4 hours since the onset of symptoms. Heart type fatty acid binding protein (h-FABP), involved in the intra-cellular transport of free fatty acids in the myocardium, has also been studied for this purpose. For the first time, it was found to be a marker of myocardial necrosis in 1988. Owing to smaller size of h-FABP (14–15 KDa) than troponin I (cTnI) and higher concentration in the cardiac myocytes (2 to 10 times) than skeletal muscle, it appears early in the circulation than cTnI in response to myocardial injury.⁵ It begins to appear in the circulation as early as 30 minutes and becomes detectable within 90 minutes of myocardial injury; rises to its peak value within 4–6 hours and decreases within 24 hours facilitating detection of recurrent events.⁶ In the early hours of symptoms, h-FABP is approximately 20-fold more specific than myoglobin and more sensitive than cardiac troponins.⁷ Rapid point-of-care test (POCT) of h-FABP is also available which shows similar results and can diagnose the patient within 15 minutes.⁸ All these features make the h-FABP, an important tool for the earlier diagnosis of infarction. However, studies have shown variable correlation of h-FABP with cardiac troponins and other cardiac markers.^{3,9}

Recent studies have demonstrated that the h-FABP is a better biomarker during first 6–8 hours of myocardial necrosis.^{10,4,8} Naroo GY *et al.*, reported higher sensitivity (75.76% vs 58.59% vs 68.69%) and comparable specificity (96.97% vs 98.84% vs 97.54%) of h-FABP as compared to troponin T and CKMB respectively (in the first 6 hrs). Kim SK *et al.*, demonstrated that the h-FABP is superior to both myoglobin and CKMB as an adjunct to cTnI for the early detection of MI. Chandran PA *et al.*,¹⁰ while comparing h-FABP and cTnI found higher sensitivity (56.7% vs 40%), equal specificity (100% vs 100%), positive predictive value (100% vs 100%), and superior negative predictive value of h-FABP (62.9% vs 55%).

However, there are conflicting results from some studies like Rosmon J *et al.*,³ demonstrated that cardiac troponin had higher sensitivity than h-FABP for the diagnosis of acute MI and h-FABP did not appear earlier than troponins.⁵ Similarly, Banu S *et al.*,⁵ showed that the hs-Trop I (not conventional cTnI or POC test) is a more sensitive marker than h-FABP in early hrs of AMI.³ And since, no such data is available in locally, we wanted to assess the utility of Point of care h-FABP test in the early hours of myocardial infarction and compare its window period response with that of point-of-care troponin-I.

MATERIAL AND METHODS

The study was conducted after approval from the local ethical committee. Diagnosed patients of acute STEMI, admitted in the emergency department of Rawalpindi Institute of Cardiology from January to June 2015 were scrutinized using the inclusion criteria. The blood samples of 150 patients for both h-FABP and cTnI were withdrawn after taking informed consent. Patients with age between 18–70 year, having first episode of chest pain, presenting within six hours and diagnosed as STEMI based on the criteria defined in Third Universal definition of Myocardial infarction (By 2012 Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction)¹¹ were enrolled in the study. Twenty-five patients were excluded based on one of the following features; non-cardiac chest pain, recent injuries, had thrombolytic therapy started before withdrawal of blood sample or those with known renal failure and skeletal muscle disorders, had NSTEMI, and/or who underwent prior PCI. The data from remaining 125 cases was further analysed.

All patients meeting the inclusion criteria underwent clinical assessment including clinical history, relevant physical examination, Blood pressure monitoring, TIMI score was calculated and Killip class was assessed, 12 lead ECG, continuous

ECG monitoring, X-ray chest and 2D-Echocardiography was done in all the patients. Information with respect to hypertension, diabetes, family history of ischemic heart disease, smoking status was taken from all the patients.

Five ml venous blood was drawn from all patients within 20 minutes of presentation in emergency department and collected in EDTA (Ethylene Diamine Tetra Acetic Acid Potassium salt) bottle. Tests were conducted in emergency department for quantitative and qualitative measurement of Trop I and h-FABP by immunofluorescence method using Point of care testing Kits {"Hubi-HFABP" and "Hubi 2 in 1(CKMB+TNI)"}. The tests were performed on a point of care cardiac marker instrument manufactured by Humasis Korea, named "Hubi Qan Pro". The cut off value for cTnI was 0.4 ng/dl and for HFABP 0.6 ng/dl as per manufacturers claim.¹³ Results were available just after 15 mins from the machine. Trop-I of all patients were repeated after 12 and 24 hours to confirm the diagnosis of STEMI and risk stratification.

Statistical analyses were performed using SPSS version 19.0. Frequencies and percentages were calculated for categorical variables. The mean and standard deviations were calculated for continuous variables. Sensitivity of cTnI and h-FABP was calculated with formula: True positives/True positives plus false negatives x100. The data was then stratified according to the time of presentation since the onset of symptoms (0–2 hrs, 2–4 hrs and 4–6 hrs) and the sensitivity of each test was calculated for each window period separately. Comparison of proportion of patients with positive cTnI and positive h-FABP, amongst confirmed patients of AMI was made using Chi square test at 5% level of significance. Normality of the numeric data was assessed using Shapiro-Wilk test. To compare the mean levels of cTnI and h-FABP with respect to window periods (2 hrs, 2–4 hrs and 4–6 hours) Nonparametric (Kruskal Wallis) test was applied. A *p*-value of less than 0.05 was considered statistically significant. Pearson correlation test was applied to study the correlation of different groups of numeric variables.

RESULTS

Overall 125 patients met the inclusion criteria, 112 (89.6%) of them were males and 13 (10.4%) were females (M:F=9:1). Mean age of the study population was calculated to be 54.26±9.53. Females had higher mean age than male patients but with no statistically significant difference (57.62±7.33 vs 53.88±9.71; *p*=0.18). Evaluation of coronary artery disease risk factors revealed that 25.6% (n=32) were known

diabetics, 41.6% (n=52) were known hypertensive, and 6.4% (n=8) of patients had family history of ischemic heart disease, 67.2% (n=84) patients were active smokers and 3.2% (n=4) patients were known to have dyslipidaemia. Table-1 summarizes baseline characteristics of study population defined by detailed history. Evaluation of ECG data revealed that anterior wall myocardial infarction (AWMI) as most common type of MI occurring in 41 patients (32.8%). Anterolateral wall myocardial infarction in 26 patients (20.8%), Inferior wall myocardial infarction in 34 patients (27.2%), Postero-inferior wall myocardial infarction in 21 patients (16.8%), whereas acute left bundle branch block (LBBB) was least common type occurring in 3 patients (2.4%). Thrombolytic therapy with streptokinase was predominant mode of reperfusion (96%, n=120). Primary PCI was performed in only selected patients (4%, n=5); who were young and at higher risk. Owing to lack of adequate resources, the thrombolytic therapy is the major reperfusion strategy in our institution.

Overall, the h-FABP has higher sensitivity than cTnI for the detection of Myocardial infarction, especially in the early presenters. h-FABP test was positive in significantly higher number of patients than the cTnI (90 vs 33; $p=0.000$). This translated into 2.7 times higher sensitivity of h-FABP as compared to the cTnI (72% vs 26.4%). At 12 hours, both cTnI and h-FABP both were 100% sensitive.

Among the study population the time of presentation since the onset of symptoms ranged from 0.5–6h, with mean duration of 3.19±1.44 hours. 27.2% (n=34) patients presented within 2 hours of onset of symptoms, whereas, 49.6% (n=62) and 23.2% (n=29) presented in 2–4 and 4–6 hours window respectively. Among patients presenting within 2 hrs of onset of symptoms h-FABP was more sensitive than troponin I although, overall sensitivity was low in this subgroup. Out of 34 patients in this subgroup, all patients were cTnI negative whereas, 35.3% (n=12) were h-FABP positive.

Among patients who presented within 2–4 hours window period, 17.7% (n=11) were cTnI positive and 82.3% (n=51) were cTnI negative whereas, 79% (n=49) were H-FABP positive and 21% (n=13) were H-FABP negative. So, H-FABP was more sensitive than cTnI (79% vs 17.7%) in this subgroup too. Among patients presenting within 4–6

hours window period, 75.9% (n=22) were cTnI positive and 24.1% (n=7) were cTnI negative, whereas, 100% (n=29) patients were H-FABP positive. So, the sensitivity of cTnI with regard to window period (2h, 2–4h and 4–6h) was 0%, 17.7%, and 75.9%, whereas sensitivity of H-FABP 35.3%, 79.03% and 100% respectively. Table 3 summarizes the sensitivity of cTnI and h-FABP with respect to the time of testing since the onset of symptoms, whereas table-2 summarizes the overall sensitivity of cTnI and h-FABP in patients presenting within six hours of onset of symptoms.

Statistically significant difference was observed between the median cTnI values with respect to window period (<2 hrs, 2–4 hrs and 4–6 hrs; 0.05 (IQR: 0.00), 0.05 (IQR: 0.22) & 2.27 (IQR: 5.38) respectively, $p=0.000$). Similarly, there was statistically significant difference between median FABP levels with regards to window period (<2 hrs, 2-4 hrs and 4–6 hrs; 2.605 (IQR: 19.95), 19.845 (IQR: 27.79) & 40.00 (IQR: 73.90) respectively, $p=0.000$). cTnI was observed to be positively and strongly correlated with time of presentation since the onset of symptoms ($r =0.551$, $p=0.000$) and FABP levels ($r =0.551$, $p=0.000$) but there was no correlation with age ($r =0.148$, $p=0.09$). Similarly, FABP showed positive correlation with time in hours since the onset of symptoms ($r =0.442$, $p=0.000$) and cTnI levels but no correlation with age ($r =0.16$, $p=0.074$).

Table-1: Characteristics of the study population

Characteristics	Values
N	125
Mean age in years	54.26±9.53
Risk Factors	
Diabetes Mellitus	25.6% (n=32)
Hypertension	41.6% (n=52)
Smoker	67.2% (n=84)
Dyslipidaemia	4.0% (n=5)
Family history	6.4% (n=8)
Mean duration of presentation	3.19±1.44 hrs
Mean ST Elevation	4.63±3.01 mm
Reperfusion therapy (%)	
Streptokinase	96% (n=120)
Primary PCI	4% (n=5)

Table-2: Overall sensitivity of cTnI and h-FABP

Sensitivity of H-FABP	TP/TP+ FN x100	90/125 x100	72% (n=90)
Sensitivity of cTn-I	TP/TP+FN x100	33/125 x100	26% (n=33)

Table-3: Sensitivity of cTnI and H-FABP with respect to the time from onset of symptoms (n=125)

Window period	cTnI positive n (%)	cTnI negative n (%)	Total	H-FABP positive n (%)	H-FABP negative n (%)	Total
< 2 hours	0	34 (100)	34	12 (35.3)	22 (64.7)	34
2–4 hours	11 (17.7)	51 (82.3)	62	49 (79)	13 (21)	62
4–6 hours	22 (75.9)	07 (24.1)	29	29 (100)	0	29
Total	33	92	125	90	35	125

DISCUSSION

Evidence from large number of trials emphasizes early recognition and prompt treatment of STEMI patients. Early treatment of STEMI not only improves short term outcome but also promises better long term prognosis. Currently, cardiac troponins are considered cornerstone for the diagnosis of such patients. But, cardiac troponin levels rise relatively slowly^{4,13} and have biphasic release after myocardial injury (small number of cytoplasmic troponins release early than cytoskeletal troponins).¹⁵ Thus in order to achieve adequate sensitivity, blood should be sampled at least 4–6 h after the onset of ischemic discomfort and sometimes repeated measurements are required at intervals of 12–24 hours. Large number of patients may have significant irreversible damage without classic symptomatology and ECG changes and require repeated measurements of biomarker levels. Such delays can lead to devastating outcomes. New high-sensitivity assays with their improved sensitivity, have made possible, the earlier detection of low-level elevations of troponin (within 90–180 minutes)^{14–16} as demonstrated by the two large prospective studies.^{17,18} Issue with laboratory testing is the time delays and costs which can be overcome using POC testing especially in emergency department. Similarly, some studies have shown over diagnosis of NSTEMI-ACS with hs-cTnI.¹⁹ Also, cardiac troponin levels remain elevated for 7–14 days after myocardial necrosis which limits its sensitivity for detection of recurrent myocardial necrosis.¹⁵

H-FABP has been considered as biomarker of ischemia and begins to rise as early as 30 mins and becomes detectable in 90 minutes from onset of symptoms thus facilitating the earlier detection and management alongside Troponins.²⁰ Kim KS *et al.*, demonstrated that the initial h-FABP (POC test) was superior to initial myoglobin or initial CKMB in combination with the initial cardiac troponins. Explanation for this comes from the observations that the h-FABP levels are 2–10 times higher in cardiac muscle than skeletal muscle, whereas, skeletal muscles have 2-folds higher level of myoglobin than cardiac muscle. Similarly, normal base line level myoglobin is considerably high than h-FABP.⁴

Studies comparing the h-FABP and cardiac troponins revealed that h-FABP is released and detected earlier after myocardial injury, and hence, seems superior to cardiac troponins.²¹ Some studies though have also demonstrated lower sensitivity of h-FABP. One such study by Banu S *et al.*,⁶ showed better

sensitivity of cTnI than h-FABP used high sensitivity assays of troponin I. Whereas, in our study we compared the POC cTnI and POC FABP tests which showed better sensitivity of h-FABP. Point of care testing (POCT) significantly reduces time to test and length of stay in emergency department (as results are available in 15 minutes).^{22,23} Various studies have demonstrated that h-FABP also carries prognostic significance in patients with ACS.^{24–26}

In our study, we categorized the patients in three groups according to the time since the onset of symptoms with mean time of presentation was 3.19±1.44 hours. 27.2% (n=34) patients presented within 2 hrs of ischemic symptoms, whereas, 49.6% (n=62) and 23.2% (n=29) presented in 2–4 and 4–6 hours window respectively. Overall, the HFABP had higher sensitivity than cTnI in all three subsets (35.3%, 79%, 100% vs 0%, 17.7%, 75.9%). Our study was a cross sectional, in which we compare sensitivity POCT h-FABP and cTnI in patient presenting STEMI within 6 hours of chest pain. We found that overall sensitivity of POC h-FABP (78%) was significantly higher than cTnI which was 57%.

The results of our study are in-line with other recently conducted studies. One such study by Body *et al.* used eight cardiac biomarkers to early exclude myocardial infarction in their 705 patients and found that the h-FABP had significantly higher AUC of 0.86% than any other cardiac marker including cardiac troponins T. In this study, the median sampling time was 3.5 hours after the symptom onset.²⁷ In another study the effectiveness of h-FABP in different time period from the onset of symptoms and different ethnic background for the detection of acute myocardial necrosis were investigated in which 289 patients were recruited, admitted within 12 hours of symptom onset. Their study showed that there is higher sensitivity of to have higher diagnostic accuracy of h-FABP immune test than cTnI and CK-MB in patients presenting within 3h of onset of ischemic symptoms.²⁸

There are certain limitations in this study. First, we used POC test instead of high sensitivity test. Secondly, only STEMI patients were enrolled excluding NSTEMI-ACS. And lastly, the number of patients was limited to 125. More studies with higher number of patients are required to further strengthen the evidence.

CONCLUSION

The result of this study demonstrates that POC h-FABP is more sensitive marker than troponins in STEMI. However, for better confirmation, cardiac troponins and h-FABP should be used in combination.

Acknowledgement: The h-FABP kits were provided free of cost by Future Scientific Pakistan.

AUTHORS' CONTRIBUTION

The Data collection, Statistical analysis and Article writing was done by WAA, MS and SR. Supervised by AMK.

REFERENCES

- Kolansky DM. Acute coronary syndromes: morbidity, mortality, and pharmaco-economic burden. *Am J Manag Care* 2009;15(2 Suppl):S36–41.
- Marceau A, Samson JM, Laflamme N, Rinfret S. Short and Long-Term Mortality after STEMI versus NON-STEMI: A Systematic Review and Meta-Analysis. *J Am Coll Cardiol* 2013;61(10):E96.
- Rosman J, Kavala G, Obunai K, Bergmann SR. The role of heart-type fatty acid-binding protein in the diagnosis of acute coronary syndrome. *Int J Angiol* 2009;18(2):79–81.
- Kim KS, Lee HJ, Kim K, Jo YH, Kim TY, Lee JH, *et al.* Heart-type Fatty Acid Protein as an Adjunct to Cardiac Troponin-I for the Diagnosis of Myocardial Infarction. *J Korean Med Sci* 2011;26(1):47–52.
- Banu S, Tanveer S, Manjunath CN. Comparative study of high sensitivity troponin T and heart-type fatty acid-binding protein in STEMI patients. *Saudi J Biol Sci* 2015;22(1):56–61.
- Banu KY, Niyazi OD, Erdem C, Afsin DH, Ozlem U, Yasmin C, *et al.* Value of heart-type fatty acid-binding protein (H-FABP) for emergency department patients with suspected acute coronary syndrome. *Afr Health Sci* 2014;14(3):757–62.
- Seino Y, Tomita Y, Takano T, Ohbayashi K. Office cardiologists cooperative study on whole blood rapid panel tests in patients with suspicious Acute myocardial infarction: comparison between heart-type fatty acid-binding protein and troponin T tests. *Circ J* 2004;68(2):144–148.
- Naroo GY, Ali SM, Butros V, Al Haj A, Muhammad I, Alosert M, *et al.* Elevated heart-type fatty acid-binding protein predicts early myocardial injury and aids in the diagnosis of non-ST elevation myocardial infarction. *Hong Kong J Emerg Med* 2009;16:141–7.
- Liebetrau C, Möllmann H, Nef H, Szardien S, Rixe J, Trold C, *et al.* Release kinetics of cardiac biomarkers in patients undergoing transcatheter ablation of septal hypertrophy. *Clin Chem* 2012;58(6):1049–54.
- Chandran PA, Wani BA, Satish OS, and Mohammed N. Diagnosis of Non-ST-Elevation Acute Coronary Syndrome by the Measurement of Heart-Type Fatty Acid Binding Protein in Serum: A Prospective Case Control Study. *J Biomark* 2014;2014:624930.
- Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD, *et al.* Third universal definition of myocardial infarction. *Circulation* 2012;126(16):2020–35.
- Alhashemi JA. Diagnostic accuracy of a bedside qualitative immunochromatographic test for acute myocardial infarction. *Am J Emerg Med* 2006;24(2):149–55.
- Pantegni M, Pagani F, Bonetti G. The sensitivity cardiac markers: an evidence-based approach. *Clin Chem Lab Med* 1999;37(11-12):1097–106.
- Than M, Cullen L, Aldous S, Parsonage WA, Reid CM, Greenslade J, *et al.* Two-hour accelerated diagnostic protocol to assess patients with chest pain symptoms using contemporary troponins as the only biomarker: the ADAPT trial. *J Am Coll Cardiol* 2012;59(23):2091–8.
- Cullen L, Muller C, Parsonage WA, Wildi K, Greenslade JH, Twerenbold R, *et al.* Validation of high-sensitivity troponin I in a 2-h diagnostic strategy to assess 30-day outcomes in emergency-department patients with possible acute coronary syndrome. *J Am Coll Cardiol* 2013;62(14):1242–9.
- Reichlin T, Schindler C, Drexler B, Twerenbold R, Reiter M, Zellweger C, *et al.* One-hour rule-out and rule-in of acute myocardial infarction using high-sensitivity cardiac troponin T. *Arch Intern Med* 2012;172(16):1211–8.
- Keller T, Zeller T, Peetz D, Tzikas S, Roth A, Czyn E, *et al.* Sensitive troponin I assay in early diagnosis of acute myocardial infarction. *N Engl J Med*. 2009;361(9):868–77.
- Reichlin T, Hochholzer W, Bassetti S, Steuer S, Stelzig C, Hartwiger S, *et al.* Early diagnosis of myocardial infarction with sensitive cardiac troponin assays. *N Engl J Med* 2009;361(9):858–67.
- Hall TS, Hallén J, Agewall S, Atar D, Jensen T. Changes in diagnosing non-ST-segment elevation myocardial infarction after the introduction of a new high-sensitivity cardiac troponin T assay: a single-centre experience. *Clin Lab* 2012;58(9-10):1029–36.
- Randex. H-FABP Biomarker of myocardial ischemia. [Internet]. 2013 Randex Laboratories Ltd [Cited 2015 Aug 1]. Available from: <http://www.h-fabp.com/>
- Hastrup B, Gill S, Kristensen SR, Jorgensen PJ, Glatz JF, Haghfelt T, *et al.* Biochemical markers of ischemia for early identification of acute myocardial infarction without ST segment elevation. *Cardiology* 2000;94(4):254–61.
- Singer AJ, Williams J, Taylor M, Le Blanc D, Thode HC Jr. Comprehensive bedside point of care testing in critical ED patients: a before and after study. *Am J Emerg Med* 2015;33(6):776–80.
- Singer AJ, Ardise J, Gulla J, Cangro J. Point-of-care testing reduces length of stay in emergency department chest pain patients. *Ann Emerg Med* 2005;45(6):587–91.
- Huang CH, Tsai MS, Chien KL, Hsu CY, Chang WT, Wang TD, *et al.* Prognostic relevance of plasma heart-type fatty acid binding protein after out-of-hospital cardiac arrest. *Clin Chim Acta* 2014;435:7–13.
- Matsumoto S, Nakatani D, Sakata Y, Suna S, Shimizu M, Usami M, *et al.* Elevated serum heart-type fatty acid-binding protein in the convalescent stage predicts long-term outcome in patients surviving acute myocardial infarction. *Circ J* 2013;77(4):1026–32.
- Viswanathan K, Kilcullen N, Morrell C, Thistlethwaite SJ, Sivanathan MU, Hassan TB, *et al.* Heart-type fatty acid-binding protein predicts long-term mortality and re-infarction in consecutive patients with suspected acute coronary syndrome who are troponin-negative. *J Am Coll Cardiol* 2010;55(23):2590–8.
- Body R, McDowell G, Carley S, Wibberley C, Ferguson J, Mackway-Jones K. A FABP-ulous 'rule out' strategy? Heart fatty acid binding protein and troponin for rapid exclusion of acute myocardial infarction. *Resuscitation* 2011;82(8):1041–6.
- Xu Q, Chan CP, Cao XY, Peng P, Mahemuti M, Sun Q, *et al.* Cardiac multi-marker strategy for effective diagnosis of acute myocardial infarction. *Clin Chim Acta* 2010;411(21-22):1781–7.

Received: 27 October, 2016	Revised: 19 January, 2017	Accepted: 23 January, 2017
----------------------------	---------------------------	----------------------------

Address for Correspondence:

Dr. Muhammad Saleem, Rawalpindi Institute of Cardiology, Rawalpindi-Pakistan

Cell: +92 335 534 0608

Email: drmsaleem05@gmail.com