 DOI : 10.48165/jiafm.2023.45.2.13

ORIGINAL ARTICLE

Diagnostic Efficacy of Troponin – I qualitative Rapid test in Sudden Cardiac Deaths

Kumar PP,[1] Sabale PR,[2] Amonkar GP.[3]

Assistant Professor,[1] Professor (Addl.) and Head,[2] Associate Professor.[3]

1. Department of Forensic Medicine, ACSR Govt. Medical College, SPSR Nellore.
2. Department of Forensic Medicine, Topiwala National Medical College, Mumbai.
3. Department of Pathology, Topiwala National Medical College, Mumbai.

Abstract:

Everyone knows by conducting autopsy cause of sudden unexpected death can be established. However due to limitations of staff, budget and time it forces the autopsy surgeon to triage the cases. Out of which sudden cardiac deaths because of acute myocardial infarction constitute a significant percentage of caseload. When an autopsy is performed, there may be significant cardiovascular disease but there will be no gross or histological evidence of an acute myocardial infarct unless the patient survived for few hours. Troponin I (cTnI) done using peripheral blood was sampled percutaneously before conducting internal examination of each of 60 autopsies. The rapid assay result, histopathological results were tabulated and subsequently correlated. Out of 30 cases all showed positive result but in 30 controls 11 showed false positive results and 19 showed negative results. This result was statistically significant according to the chi-square test. The sensitivity of this assay in detecting cardiac-related death was 100%, with a specificity of 63.33%. In the appropriate setting, this rapid assay for cTnI can provide valuable data supportive of a cardiac-related death. This inexpensive test may best be used in triaging sudden deaths in persons and may optimize the use of the time and resources of the autopsy pathologist.

Keywords: Troponin – I; Acute MI; Sudden deaths.

Introduction:

In the world one of the most leading causes of sudden death is mainly due to cardiac in origin in both developing and developed countries, accounting almost 50% of all deaths. In sudden cardiac deaths, acute myocardial infarction is the leading cause of morbidity and mortality.[1,2]

Sudden cardiac deaths because of acute myocardial infarction constitute a significant percentage of the caseload for autopsy surgeons. When an autopsy is performed, there may be significant cardiovascular disease but there will be no gross or histological evidence of acute myocardial infarct unless the patient survived for several hours following the event. Since in an estimate, infarction is not apparent on gross examination until 12-24 hours and light microscopic (H & E) changes are not apparent before 4-6 hours. Due to this acute myocardial infarction remains undiagnosed even after conducting autopsy.[3]

Consequently depending upon the blockage of coronary artery forensic experts have to diagnose the cause of death as acute coronary insufficiency which cannot be considered as the immediate cause of death. Similarly in instances like a driver sustaining head injury after angina, it is very challenging to decide whether the driver had died of myocardial infarction due to non-availability of confirmatory test.[4]

Corresponding Author

Dr. P. Pavan Kumar

Email : pavan95kumar105@gmail.com,

Mobile No. : +91-9701916036

Article History

DOR : 10.08.2022 DOA : 10.04.2023

Because of these limitations of autopsy findings and histopathological findings, it is necessary to establish some alternative tests. Diagnostic utility of different biochemical cardiac markers in biological fluids for postmortem diagnosis of MI is crucial. Since myocardial infarction is accompanied by the release of structural proteins and other intracellular macromolecules into the cardiac interstitium, like Creatine kinase, Myoglobin, Lactate dehydrogenase and Aspartate aminotransferase were some of the classical used conventional biochemical marker for autopsy cases. But because of low specificity of these conventional biomarkers for cardiac injury, the search for more specific alternative biomarkers recently gained momentum.[3]

Biochemical assays of creatine kinase MB fraction (CKMB) performed on serum has been used to document myocardial injury in the absence of morphologic changes. But newly developed assays for cardiac troponin I (cTnI) may detect myocardial injury with a greater sensitivity than CKMB.[5]

Troponin I, C and T form a complex that regulates the calcium modulated interaction of actin and myosin in striated muscle. In contrast to troponin C, immunoassays directed at troponin T and I allow for specific assessment of myocardial ischemia. Cardiac troponin T and I can be used for the diagnosis of acute MI. Cardiac troponin I (cTnI) is more specific marker than any other, because it does not have cross-reactivity and never has been found in a healthy population. Also, its sensitivity allows detection of even micro infarction and acute myocardial infarction much earlier after the onset of ischemia by using a rapid one-step assay in body fluids in autopsy cases.[3,6-8]

In this study our aim is to evaluate the diagnostic efficacy of

Troponin - I in sudden cardiac deaths and our objectives are to analyze the results of rapid Troponin - I test in subjects who died of sudden cardiac causes and non-cardiac causes and also to correlate the results of rapid Troponin - I test with histopathological findings.

Materials and Methods:

The study was conducted on the dead bodies brought for autopsy with history of sudden death at the mortuary attached to tertiary care hospital after obtaining clearance from institutional ethics committee.

The present study is a Prospective Case Control study conducted in the department of Forensic Medicine.

Total 60 cases of routinely performed autopsies were included and divided into two groups as cardiac group (history suggesting cardiac signs and symptoms) (n=30) and the other one non-cardiac group (asphyxial deaths, traumatic deaths without chest trauma, natural diseases other than IHD) (n=30).

Inclusion Criteria: All the suspected cases of acute myocardial infarction brought dead to the casualty and admitted cases died undiagnosed with history of chest pain.

Sometimes other signs and symptoms will precede sudden cardiac arrest. So history of frequent episodes of chest pain or discomfort, heart palpitations, irregular or rapid heartbeats, fatigue, blackouts, weakness, vomiting, unexplained wheezing or shortness of breath, fainting or near fainting, feeling light headed or dizzy also taken into consideration but sudden cardiac arrest may often occurs with no warning.

Non cardiac deaths will be included as control. This will include natural cases other than ischemic heart disease, violent asphyxial deaths and deaths due to polytrauma without any evidence of chest trauma.

Exclusion Criteria: For cardiac group - traumatic injuries to heart, unknown cases, known case of cardiac disease within 08 to 10 days of previous episode, autopsy cases in which postmortem interval is more than 48 hours.

For non-cardiac group - traumatic injuries to heart, unknown cases In every case after external examination blood sample was collected by using a sterile syringe from the peripheral blood vessels (femoral). Subsequently sample was centrifuged and by using plastic dropper plasma was taken and placed in the well of troponin - I kit. Results were noted after 10 minutes, if red colored coating noted at both t and c line it was considered as positive result, if it was noted at only c-line, it was considered as negative and if it was noted at only t-line, it was considered as invalid and test was repeated with new kit. All this results were confirmed only after 10 minutes test procedure.

During autopsy after collecting the sample, heart was separated from thoracic block, gross findings of heart and coronaries noted, later histological evaluation also done.

Data collected and entry was done in excel. Data and statistical analysis were done by using statistical package for the social sciences (SPSS) software. Appropriate statistical tests were employed for the evaluation of data.

Table 1. Distribution of cases in cardiac and non-cardiac groups based on results of troponin – I qualitative Rapid test (n = 60).

Troponin – I	Cardiac (n=30)	Non-Cardiac (n=30)	
Positive	30 (50%) True Positive	11 (18%) False Positive	Positive Predictive Value (ppv) = 73.17%
Negative	0 (0%) False Negative	19 (32%) True Negative	Negative Predictive Value (npv) = 100%
	Sensitivity = 100%	Specificity = 63.33%	Accurac Y= 81.66%

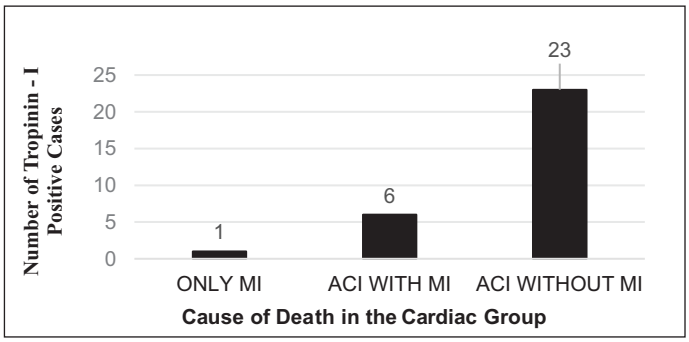
Table 2. Final cause of death in the cardiac group cases and results of troponin – I test (n=30).

Sr No.	Cardiac Group Cases (n=30)	Final Cause of Death	Troponin – I Rapid Test	Number of Cases
1.	Only MI	Acute on chronic myocardial infarction	Positive	1
2.	ACI with MI	Acute on chronic myocardial infarction associated with acute coronary insufficiency	Positive	6
3.	ACI without MI	Acute myocardial infarction associated with acute coronary insufficiency	Positive	23
Total				30

Table 3. Final cause of death in the non – cardiac group cases and results of troponin – I test (n=30).

Sr No.	Non-Cardiac Group Cases (n=30)	Final Cause of Death (After Hp and Troponin-I Results)	Troponin – I Rapid Test		Total Number of Cases
			Positive	Negative	
1.	Known case of Alcoholic liver disease	Cerebropulmonary edema in a known case of alcoholic liver disease	2	3	5
		Hypovolemic shock following upper GI bleed in a case of alcoholic liver disease	0	2	2
		Cirrhosis of liver in a known case of alcoholic liver disease	0	1	1
		Pneumonia in a case of alcoholic liver disease	1	1	2
		Acute pancreatitis in a known case of alcoholic liver disease	0	1	1
2.	Known case of Acute febrile illness	Cerebropulmonary edema in a known case of acute febrile illness	0	3	3
		Cerebropulmonary edema with intrapulmonary hemorrhage in a known case of acute febrile illness	1	1	2
		Pneumonia in a case of acute febrile illness	1	2	3
3.	Hanging	Asphyxia due to hanging	2	3	5
4.	Decapitation	Shock due to decapitation	2	0	2
5.	Road traffic accident (RTA)	Head injury due to RTA	1	0	1
6.	Fall from height	Head injury due to fall from height	1	0	1
7.	Known case of right foot gangrene	Pneumonia in a case of right foot gangrene	0	1	1
8.	Acute Pancreatitis	Acute pancreatitis	0	1	1
Total			11	19	30

 DOI : 10.48165/jiafm.2023.45.2.13



Graph 1. Final cause of death in the cardiac group cases and results of troponin – I test (n=30).

The association among study group will be assessed with Pearson chi-square test and p value less than 0.05 is taken as significant level.

Results :

In our present study all were aged below 50 years age, out of 60 cases 41 (68.33%) cases came positive for troponin –I test and 19 (31.67%) cases were negative.

In cardiac group (30 cases) all cases were positive for troponin – I test. In non-cardiac group (30 cases), 11 cases were positive for troponin – I test, 19 cases were negative. Sensitivity of test was 100% and specificity 63.33%. Positive and Negative Predictive Value were 68.97% and 78.95% respectively. It suggests that in our study the ability of test to identify those with the disease is 100%, but the ability of the test to identify those without the disease is 63.33%.

Diagnostic efficacy (accuracy) of troponin – I qualitative rapid test in our study is 81.66%.

'p value is <0.00001(significant).'

Discussion:

In this study, diagnostic efficacy of troponin – I qualitative rapid test in our study is 81.66%, it suggests that accuracy of the test to detect number of cases with disease and without disease is 81.66%.

There are no autopsy studies to compare the sensitivity, specificity and diagnostic efficacy of troponin – I qualitative rapid test. However, studies on troponin – t qualitative rapid test, quantitative analysis of troponin – I, troponin – T and other cardiac markers are available.

In the cardiac group all cases were positive to troponin – I qualitative rapid test and along with histopathological findings in which all cases shown some significant changes of heart which helps to confirm that they were died because of acute myocardial infarction, this is consistent with Cina SJ et al.[9] and Batalis NI[10] studies.

In non-cardiac group, 11 cases came positive for troponin – I qualitative rapid test in which 3 cases were known cases of alcoholic liver disease in which there were some findings suggesting cardiomyopathy is more likely to develop at an advanced state of liver function loss. This is also observed in the studies of Ortiz-Olvera et al.,[11] Wehmeyer MH et al. [12] In 2 cases of acute febrile illness, no significant changes in the gross and microscopy of heart were observed and the reason for positive troponin –I test could be determined. Zhu BL, [8] Zhu BL,[13] Zhu BL[14] also noticed rise of troponin levels in cases of acute febrile illness. In 2 cases of asphyxia due to hanging the troponin –I test results positive without underlining cardiac pathology. The reason might be an intense agony with consequent acute myocardial suffering due to which there may be release of biomarkers in the heart leading false results. The similar findings are also observed by Zhu BL et al.,[8] Zhu BL et al.,[13] Zhu BL et al.,[14] Pérez Carceles MD et al.,[15] and Martínez Díaz F et al.[16]

The troponin – I test also turn positive in a case of decapitation and 2 cases of head injury caused due to road traffic accident and fall from height. White HD et al.[17] in their study stated that in such circumstances due to some amount of stress, troponin may be released as a result of tachycardia stimulating stretch-responsive integrins. Pérez Carceles MD et al.,[15] Martínez Díaz F et al.[16] also stated that some undetermined cardiac traumatism may have been involved. However none of these cases shown significant gross and histopathological findings that were conclusive evidence of cardiac pathology or traumatization.

In non-cardiac group, 19 cases came negative for troponin – I qualitative rapid test did not show any findings for the evidence of cardiac pathology on gross and histopathological examination.

Conclusion:

Troponin – I qualitative rapid test can be used in sudden deaths but some guidelines should be made. To get accurate results along with rapid troponin – I test, quantitative analysis should be practiced. In future if this study is studied in large population it will help the autopsy surgeon to find cause of sudden deaths.

In virtual autopsy setup, this type of rapid testing helps the autopsy surgeon to find the cause of death and decreases the duration of time and also helps to decrease the work load of autopsy surgeon. However, histopathology studies should be always done in cases of young cardiac SNDs, to rule out hidden pathologies such as Myocarditis, Cardiomyopathy etc.

Funding: "This research received grant from The Research Society, B. Y. L. Nair Ch. Hospital & T. N. Medical College, Mumbai".

Conflict of Interest: 'The Authors declares that there is no conflict of interest.'

References:

1. Honnekeri BS, Lokhandwala D, Panicker GK, Lokhandwala Y. Sudden Cardiac Death in India: A Growing Concern. J Assoc Physicians India. 2014 Dec;62(12):36-40.
2. Cohle SD, Sampson BA. The negative autopsy: sudden cardiac death or other? Cardiovasc Pathol. 2001 Sep-Oct;10(5):219-22.
3. Mustafa GH, Gorea RK, Rahman S, Khan MS. Diagnostic efficacy of cardiac troponins in post-mortem examination of acute myocardial infarctions. Int J Eth Trauma Victimology. 2015; 1(1):21-28.

4. Verma AK, Kumar S, Kumar N, Verma RK, Singh M. Study of Coronary Artery Atherosclerosis in Sudden Deaths and Its Medico-legal Relevance (Original Research Paper). J Indian Acad Forensic Med. 2012 April-June; 34(2):0971-0973.
5. Cina SJ, Li DJ, Chan DW, Boitnott JK, Hruban RH, Smialek JE. Serum concentrations of cardiac troponin I in sudden death: a pilot study. Am J Forensic Med Pathol. 1998 Dec;19(4):324-8.
6. Etievent JP, Chocron S, Toubin G, Taberlet C, Alwan K, Clement F, et al. Use of cardiac troponin I as a marker of perioperative myocardial ischemia. Ann Thorac Surg. 1995 May;59(5):1192-4. doi:10.1016/0003-4975(95)00129-9.
7. Remmer S, Kuudeberg A, Tõnisson M, Lepik D, Väli M. Cardiac troponin T in forensic autopsy cases. Forensic Sci Int. 2013 Dec 10;233(1-3):154-7.
8. Zhu BL, Ishikawa T, Michiue T, Li DR, Zhao D, Bessho Y, et al. Postmortem cardiac troponin I and creatine kinase MB levels in the blood and pericardial fluid as markers of myocardial damage in medicolegal autopsy. Leg Med (Tokyo). 2007 Sep;9(5):241-50.
9. Cina SJ, Brown DK, Smialek JE, Collins KA. A rapid postmortem cardiac troponin T assay: laboratory evidence of sudden cardiac death. Am J Forensic Med Pathol. 2001 Jun;22(2):173-6.
10. Batalis NI, Marcus BJ, Papadea CN, Collins KA. The role of postmortem cardiac markers in the diagnosis of acute myocardial infarction. J Forensic Sci. 2010 Jul;55(4):1088-91.
11. Ortiz-Olvera NX, Castellanos-Pallares G, Gómez-Jiménez LM, Cabrera-Muñoz ML, Méndez-Navarro J, Morán-Villota S, et al. Anatomical cardiac alterations in liver cirrhosis: an autopsy study. Ann Hepatol. 2011 Jul-Sep;10(3):321-6.
12. Wehmeyer MH, Heuer AJ, Benten D, Püschel K, Sydow K, Lohse AW, Lüth S. High Rate of Cardiac Abnormalities in a Postmortem Analysis of Patients Suffering From Liver Cirrhosis. J Clin Gastroenterol. 2015 Nov-Dec;49(10):866-72.
13. Zhu BL, Ishikawa T, Michiue T, Li DR, Zhao D, Oritani S, Kamikodai Y, et al. Postmortem cardiac troponin T levels in the blood and pericardial fluid. Part 1. Analysis with special regard to traumatic causes of death. Leg Med (Tokyo). 2006 Mar;8(2):86-93.
14. Zhu BL, Ishikawa T, Michiue T, Li DR, Zhao D, Kamikodai Y, et al. Postmortem cardiac troponin T levels in the blood and pericardial fluid. Part 2: analysis for application in the diagnosis of sudden cardiac death with regard to pathology. Leg Med (Tokyo). 2006 Mar;8(2):94-101.
15. Pérez-Cárceles MD, Noguera J, Jiménez JL, Martínez P, Luna A, Osuna E. Diagnostic efficacy of biochemical markers in diagnosis post-mortem of ischaemic heart disease. Forensic Sci Int. 2004 May 28;142(1):1-7.
16. Martínez Díaz F, Rodríguez-Morlensín M, Pérez-Cárceles MD, Noguera J, Luna A, Osuna E. Biochemical analysis and immunohistochemical determination of cardiac troponin for the postmortem diagnosis of myocardial damage. Histol Histopathol. 2005 Apr;20(2):475-81.
17. White HD. Pathobiology of troponin elevations: do elevations occur with myocardial ischemia as well as necrosis? J Am Coll Cardiol. 2011 Jun 14;57(24):2406-8.