Review Article

Minor Myocardial Injury: An Early Post Intervention Complication

Syeda Fahmida Afrin[1], Md. Hasanur Rahman[2], Md. Asadul Millat[3], Md. Shafiul Alam Quarashi[4], Asma Begum[5], Meherunnesa Begum[6]

Abstract

Percutaneous Coronary Intervention (PCI) is the most commonly performed invasive therapeutic cardiac procedure and plays an important role in the treatment of ischemic heart disease. Complications of Percutaneous Coronary Intervention (PCI) are relatively infrequent. The most common complications include discomfort and bleeding at the puncture site where the catheter was inserted. Major complications include death, MI, or stroke and other infrequent complications include transient ischemic attacks (minor myocardial injury), vascular complication and contrast induced nephropathy, transient ischemia, or minor myocardial injury (MMI), myocardial necrosis due to compromisation of threatened coronary circulation during balloon inflation. Cardiac Troponin I (cTnI) assays for the assessment of myocardial injury has been demonstrated for the diagnosis of MMI and long term prognosis after PCI.

Keywords: *Percutaneous Coronary Intervention; minor myocardial injury; cardiac Troponin I.*

Delta Med Col J. Jul 2017;5(2):94 – 98

Introduction

In the post Percutaneous Coronary Intervention (PCI) periods the most serious risks are death, stroke, arrhythmias, nonfatal myocardial infarction (MI), and arterial dissection. A heart attack during or shortly after the procedure occurs in 0.3% of cases; this may require emergency intervention[1] and minor complications include transient ischemia (minor myocardial injury). Occasionally, PCI creates a small tear (dissection) of an internal layer in the coronary artery. Usually, the tear is small and heals spontaneously. In some cases the tear is corrected with a stent. If the tear is severe, causing a blockage in blood flow in the artery or loss of blood around the heart, immediate

1. Associate Professor, Dept. of Biochemistry, Ibn Sina Medical College, Dhaka, Bangladesh.
2. Assistant Professor, Dept. of Cardiology, Ibrahim Cardiac Centre, Dhaka, Bangladesh.
3. Senior Consultant, Cardiology, Mugda Medical College, Dhaka, Bangladesh.
4. Assistant Professor, Dept. of Pediatrics, Ibn Sina Medical College, Dhaka, Bangladesh.
5. Associate Professor, Dept. of Forensic Medicine, Ibn Sina Medical College, Dhaka, Bangladesh.
6. Assistant Professor, Dept. of Community Medicine, Ibn Sina Medical College, Dhaka, Bangladesh.

Correspondence: Dr. Syeda Fahmida Afrin. e-mail: drfahmida77@gmail.com

treatment is given. This usually includes a repeat angioplasty and insertion of a stent. Rarely, a person may need urgent bypass surgery. Approximately 10 percent of patients develop chest pain within 48 hours of their procedure. In some cases this pain is caused by a lack of oxygen in the heart (ischemia) that occurs when a small tear (dissection) develops or pieces of the plaque material travel downstream (embolization) or to the side branch. Many patients have evidence of a very small amount of heart damage after PCI, based upon blood testing. In patients who undergo PCI with stenting, less than one percent has a heart attack large enough to cause a substantial amount of damage.[2] Concerning the early and late complication of PCI techniques like procedure induced acute MI, death or need for CABG are already the major concerns for the interventional cardiologists to get away from these major complications. With the invention of stent, use of different anticoagulant or antiplatelet drugs during procedure as observed by many large trails like 'EPISTENT'[3] 'BENESTENT'[4], these complication rates have significantly been reduced.

While considering minor complication like periprocedural transient ischemia, several pathphysiologic concepts like side branch occlusion, distal embolization, and balloon induced vessel trauma have been demonstrated by several studies. The prognosis of this minor complication is still now not determined clearly, but may have a role on late outcome of PCI, demonstrated by several studies. This acute transient ischemic insult to myocardium, which in other way has been termed as minor myocardial injury by several investigators are not typically followed by raised CKMB level as described in ACC/AHA PCI guidelines[5] as the indicator of ischemia.

Pathogenesis of minor myocardial injury (MMI)

The stenosis may then be stented directly or predilation before stenting may be done. Additional balloon dilatation may benecessary after deployment of a stent to ensure its fullexpansion.

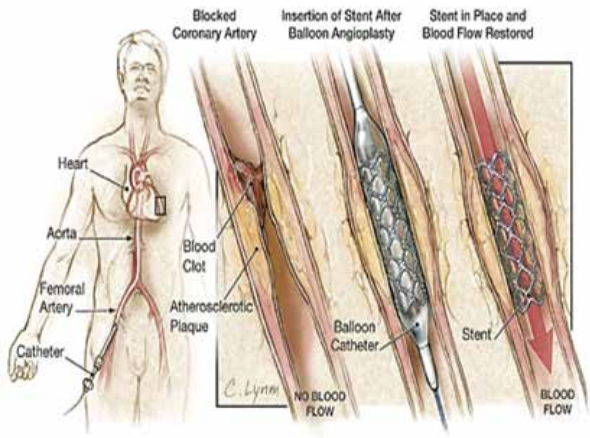

Fig 1: Procedure of Percutaneous coronary intervention

Balloon inflation inevitably stops coronary blood flow, whichmay induce angina. Patients usually tolerate this quite well, especially if they have been warned beforehand. If it becomes severe or prolonged, ischemic electrocardiographic changes are often seen at this time; although they are usually transient and return to baseline once the balloon is deflated (usually after 30-60 seconds).[6]

Diagnosis of minor myocardial injury

Several studies[7] have shown that rather Troponin-I or Troponin-T is much more a good indicator of detection of minor myocardial injury in comparison to CKMB. The incidences of minor myocardial injury due to distal embolization are more evident in balloon PCI than direct stenting as demonstrated by some observers, though this was not supported by some studies. Few studies[8] have performed to find out and compare the evidences of minor myocardial injury evidenced by the PCI procedures are not settled, several late breaking trials are focusing its role to left ventricular systolic and diastolic function.[9] Cardiac troponins are sensitive and specific markers for the detection of minor myocardial injury. However, they have been rarely used to monitor myocardial injury after coronary stenting. The purpose of the study was to measure cardiac troponin-I (cTnI) level

after elective uncomplicated successful percutaneous transluminal coronary angioplasty (PTCA) with or without stenting.[10]

Troponin

Troponin is a complex of three proteins that is integral to muscle contraction in skeletal and cardiac muscle, but not smooth muscle. Troponin is attached to the protein tropomyosin and lies within the groove between actin filaments in muscle tissue. In a relaxed muscle, tropomyosin blocks the attachment site for the myosin cross bridge, thus preventing contraction. When the muscle cell is stimulated to contract by an action potential, calcium channels open in the sarcoplasmic reticulum and release calcium into the sarcoplasm. Some of this calcium attaches to troponin, causing a conformational change that moves tropomyosin out of the way so that the cross bridges can attach to actin and produce muscle contraction. Troponin is found in both skeletal muscle and cardiac muscle, but the specific versions of troponin differ between types of muscle. The main difference is that the TnC subunit of troponin in skeletal muscle has four calcium ion binding sites, whereas in cardiac muscle there are only three.[11]

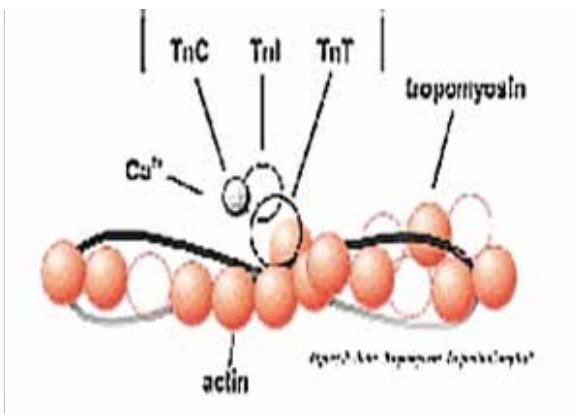

Fig 2: Schematic representation of the thin filament, showing the spatial configuration of three major protein components - actin, tropomyocin and troponin[12]

The cardiac troponin forms part of the regulatory mechanism for muscle contraction. Specific cardiac forms of cardiac troponin-T and cardiac troponin-I exist and commercially available immunoassay systems have been developed for their measurement. A large number of clinical and analytical studies have been performed and the measurement of cardiac troponins is now considered the "gold standard" biochemical test for diagnosis of myocardial damage. There have been advances in understanding the development and structure of troponins and their degradation following myocardial cell necrosis. This has contributed to the understanding of the problems with current assays. Greater clinical use has also highlighted areas of analytical and clinical confusion.[13]

Cardiac troponin-I (cTnI) is a protein marker specific for cardiac muscle with a molecular weight of 23000. Together with troponin T and C, it forms a structural complex. There are two forms of cTnI, free cTnI and cTnI I-T-C complex, which are released in blood stream after cardiac damage. TnI is found in skeletal muscle (sTnI) as well, but it differs in its amino acid composition from cTnI. These two TnI can be distinguished immunologically. The elevated level can be detected approximately 3-12 hours after onset of acute myocardial infarction (AMI). Not only TnI is specific protein marker for AMI, it also remains elevated for 7-10 days after AMI. About 6-8% of intracellular cTnT and 2.4-8% of troponin-I has been reported to remain in cytoplasm pool. Both troponins exhibit characteristic biphasic release kinetics following myocardial injury. Release from cytoplasmic pool gives rise to peak serum concentrations within 24-36 hours after injury, and structural protein release leads to a second blunted peak 2-4 days after injury. Continued breakdown of the myofibrillary-bound complex explains the prolonged elevation of both serum troponins after myocardial injury.[14, 15]

Cardiac troponin-I and T have been established as reliable and highly heart specific markers of myocyte injury. Their background concentrations in the circulation are normally undetectable or very low and they are therefore sensitive to even minor myocardial injury.[1]

Diagnostic use of troponin

Certain subtypes of troponin (cardiac troponin-I and T) are very sensitive and specific indicators of damage to the heart muscle (myocardium). They are measured in the blood to differentiate between unstable angina and myocardial infarction (heart attack) in patients with chest pain. A patient who had suffered from a myocardial infarction would have an area of damaged heart muscle and so would have elevated cardiac troponin levels in the blood.[11]

It is important to note that cardiac troponins are a marker of all heart muscle damage, not just myocardial infarction. Other conditions that directly or indirectly lead to heart muscle damage can also therefore increase troponin levels -

Cardiac	Non-cardiac
Cardiac amyloidosis	Critical illness, e.g. sepsis
Cardiac contusion	High-dose chemotherapy
Cardiac surgery and heart transplant	Primary pulmonary hypertension
Defibrillation	Pulmonary embolism
Closure of atrial septal defects	Renal failure
Coronary vasospasm	Subarachnoid hemorrhage
Dilated cardiomyopathy	Scorpion venom
Heart failure	Stroke
Hypertrophic cardiomyopathy	Very heavy exercise (marathon)
Myocarditis	
Percutaneous coronary intervention	
Radiofrequency ablation	
Supraventricular tachycardia	

The increased early sensitivity likely reflects the fact that the percentage of troponin released that reaches the blood after cardiac injury is greater for troponin than for CK-MB. Elevated troponin levels then persist in the blood owing to the slow release and degradation of the structural pool, since the half-life of troponin and its complex is about 2 hours. The prolonged window during which troponin levels are elevated allows for increased clinical detection of cardiac events and thus, functionally, greater clinical sensitivity.[16]

Troponin assays are not only more sensitive but are also more specific than CK-MB assays. Expression of CK-MB is not unique to the heart. CK-MB is found in skeletal muscle and the gastrointestinal tract as well as in the uterus of pregnant women. Moreover, in patients with myopathies, the CK-MB content of skeletal muscle can increase markedly to up to 50% of the total amount per gram of tissue. In addition, CK-MB complexes with immunoglobulin can form. Thus, elevated CK-MB levels can occur because of analytical problems, macro complexes, trauma, rhabdomyolysis, myopathies or renal failure (owing to a myopathy), or during the peripartum period.[16]

Saadeddin et al. found that among other cardiac markers cTnI and cTnT values were also elevated during post procedural period in 29% of cases who underwent elective uncomplicated successful percutaneous transluminal coronary angioplasty (PTCA) with or without coronary stenting. They concluded that minor myocardial injury is not uncommon after PTCA with or without stenting and cTn-I is more sensitive marker for the detection of this minor myocardial injury.[10]

Moreno et al.[17] demonstrated that at least one adverse event occurred during the stent implantation procedure in 34% of the cases; of which 38% had subsequent elevated TnI levels. They carried out the study by collecting data from 147 consecutive patients who had undergone percutaneous coronary revascularization by means of stent implantation and had clinically and angiographically satisfactory results. They concluded that almost 40% of the patients who suffered some adverse event during the procedures of stent implantation subsequently presented with elevated concentration of TnI. Ricciardi et al.[18] conducted the study by collecting data from 286 consecutive procedures and found that post-intervention myonecrosis-specific Tn-I was

elevated in 13.6% of patients. They concluded that Tn-I level elevation after elective PCI was relatively common and was associated with procedural complications such as incidental side branch occlusion and thrombus formation. They also demonstrated that a three-fold elevation of Tn-I after successful elective PCI is predictive of future cardiac events, especially the need for early repeat revascularization.

Conclusion

Percutaneous coronary artery stenting is one of the most important modalities of treatment for coronary artery disease. Some degrees of myocardial injury occur after successful PCI. Myonecrosis is the only procedure related factor that independently associates with long-term prognosis after PCI. Therefore, we should apply all strategies aimed at reducing it. As troponin I is the most sensitive marker to detect MMI, so this indicates the need to determine troponin I after all PCI in order to determine its prognosis of PCI-related myocardial damage.

References

1. Hamm CW, Braundwald EA. Classification of Unstable Angina Revisited. Circulation. 2000;107:984-91.
2. Aroesty JM. Percutaneous Coronary Intervention [Internet]. (cited 2008 May 5). Available from: http://www.uptodate.com/patients/content/topic.do?topicKey=hrt_dis/5829.
3. Serruys PW, van Hout B, Bonnier H. Randomized Comparison of Implantation of Heparin Coated Stents with Coronary Artery Disease (BENESTENT II). Lancet. 1998;352:673-81.
4. Serruys PW, de Jaegere P, Kiemenji F, Macaya C, Rutsch W, Heyndrickx G, et al. A Comparison of Balloon-Expandable Stent Implantation with Balloon Angioplasty in Patients with Coronary Artery Disease. BENESTENT study Group. N Engl J Med. 1994;331:489-501.
5. Anonymous. ACC/AHA Guidelines for Percutaneous Coronary Intervention. J Am Coll Cardiol. 2001;37:2239i.
6. Grech ED. Percutaneous Coronary Intervention: The Procedure. BMJ. 2003;326:1137-40.
7. La Vecchia L, Bedogni F, Finocchi G. Troponin-T, troponin-I and CKMB Mass in the Detection after Elective Coronary Stenting. Coron Artery Dis. 1996;7:535-40.
8. Atmaca Y, Altin T, Ozdal SC, Gulec S, Pamir G, Oral D. Direct Stent Implantation in Acute Coronary Syndrome. J Invas Cardiol. 2002;14:308-12.
9. Schannwell CM, Schneppenheim M, Plehn G, Strauer BE. Parameters of Left Ventricular Diastolic Function 48 Hours after Coronary Angioplasty and Stent Implantation. J Invas Cardiol. 2003;15:326-33.
10. Saadeddin SM, Habbab MA, Sobki SH, Ferns GA. Minor Myocardial Injury after Elective Uncomplicated Successful PTCA with or without Stenting: Detection by Cardiac Troponins. Cathet Cardiovasc Interv. 2001;53:188-92.
11. Wikipedia [Internet]. 2008. Coronary Artery Disease. The Free Encyclopedia (cited 2008 May 5). Available from: https://en.wikipedia.org/wiki/Coronary_artery_disease.
12. Guyton AC, Author JH. Muscle Contraction. In: Text Book of Medical Physiology. 10th ed. Singapore: Harcourt Asia PTE Ltd; 2000. p.70-71.
13. Collinson PO, Boa FG, Gaze DC. Measurement of Cardiac Troponins. Ann Clin Biochem. 2001;38:423-49.
14. Amsterdam EA, Deedwania P. Bedside Evaluation of Cardiac Marker. Postgraduate Medicine. 2005;118:3.
15. Kemp M, Donovan J, Higham H, Hooper J. Biochemical Markers of Myocardial Injury. British Journal of Anaesthesia. 2004;93:63-73.
16. Babuin L, Jaffe AS. Troponin: the Biomarker of Choice for the Detection of Cardiac Injury. CMAJ. 2005;173(10):1911-2007.
17. Moreno AR, Cardenal R, Pera C, Pagola C, Guzman M, Vazquez E, et al. Predictors and Prognostic Value of Myocardial Injury following Stent Implantation. International Journal of Cardiology. 2004;97:193-98.
18. Ricciardi MJ, Davidson CJ, Gubernikoff G, Beohar N, Eckman LJ, Parker MA, et al. Troponin I Elevation and Cardiac Events after Percutaneous Coronary Intervention. Am Heart J. 2003;145:522-28.