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# Journal of Invasive and Clinical Cardiology

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## Contents

# Journal of Invasive and Clinical Cardiology

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# Journal of
# Invasive and Clinical Cardiology




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All communications should be addressed to the Editor-in-Chief, Journal of Invasive and Clinical Cardiology. Address: Concord Windsor, House#21, Road#79, Gulshan-2, Dhaka-1212. e-mail: jicc.bit@gmail.com web: http://www.journalicc.com

# Journal of Invasive and Clinical Cardiology

## INSTRUCTION TO AUTHORS

**A. Introduction**

The Journal of Invasive and Clinical Cardiology is a biannual, peer-reviewed journal and aims to publish work of the highest quality from all sub-specialties of Cardiology. The aim of the publication is to promote research and serve as platform for dissemination of scientific information in Cardiology.

**B. Categories of Articles**

The journal accepts original research, review articles, case reports, cardiovascular images and letters to the editor, for publication.

*Original Research:*

Original, in-depth research article that represents new and significant contributions to medical science. Each manuscript should be accompanied by a structured abstract of up to 250 words using the following headings: Objective, Methods, Results, and Conclusions. 3 to 5 keywords to facilitate indexing should be provided in alphabetical order below the abstract. The text should be arranged in sections on INTRODUCTION, METHODS, RESULTS, and DISCUSSION. The typical text length for such contributions is up to 3000 words (including title page, abstract, tables, figures, acknowledgments and key messages). Number of references should be limited to 50.

*Review Articles:*

Generally review articles are by invitation only. But unsolicited reviews will be considered for publication on merit basis. Following types of articles can be submitted under this category: Newer drugs, new technologies and review of a current concept. The manuscript should not exceed 5000 words (including tables and figures). A review article should include an abstract of up to 250 words describing the need and purpose of review, methods used for locating, selecting, extracting and synthesizing data, and main conclusions. The number of references should be limited to 50.

*Case Reports:*

Only case reports of exceptional quality will be published in the case report format. The text should not exceed 1500 words and is arranged as introduction, case report and discussion. Include a brief abstract of about 150 words. Number of tables/figures should be limited to 3. Include up to 15 most recent references. The patient's written consent, or that of the legal guardian, to publication must be obtained.

*Cardiovascular Images:*

Only clinical photographs with or without accompanying skiagrams, pathological images, echocardiographic images, angiographic images etc. are considered for publication. Image should clearly identify the condition and have the classical characteristics of the clinical condition. Clinical photographs of condition which are very common, where diagnosis is obvious, or where diagnosis is not at all possible on images alone would not be considered. Photographs should be of high quality, usually 127 × 173 mm (5 × 7 in) but no larger than 203 × 254 mm (8 × 10 in). A short text of up to 250 words depicting the condition is needed. Figures should be placed exactly at a logical place in the manuscript. The submitted images should be of high resolution (>300 dpi). The following file types are acceptable: JEPG and TIFF. The number of authors should not exceed 3. The authors should ensure that images of similar nature have not been published earlier. Authors must obtain signed informed consent from the patient, or the legal guardian.

*Letter to the Editor:*

Letters commenting upon recent articles in Journal of Invasive and Clinical Cardiology are welcome. Such letters should be received within 16 weeks of the article's publication. Letters should be up to 250 words; should contain no more than 1 figure/table and up to 5 most recent references. The text need not be divided into sections. The number of authors should not exceed 3.

**C. Criteria for Acceptance**

All manuscripts should meet the following criteria: the material is original, study methods are appropriate, data are sound, conclusions are reasonable and supported by the data, and the information is important; the topic has general cardiology interest; and that the article is written in reasonably good English. Manuscripts which do not follow the guidelines of Journal of Invasive and Clinical Cardiology are likely to be sent back to authors without initiating the peer-review process. All accepted manuscripts are subject to editorial modifications to suit the language and style of Journal of Invasive and Clinical Cardiology and suggestions may be made to the authors by the Editorial Board to improve the scientific value of the journal.

**D. Editorial Process**

Journal of Invasive and Clinical Cardiology commits to high ethical and scientific standards. Submitted manuscripts are considered with the understanding that they have not been published previously in print or electronic format (except in abstract or poster form) and are not under consideration by another publication or electronic medium. Statements and opinions expressed in the articles published in the Journal are those of the authors and not necessarily of the Editor. Neither the Editor nor the Publisher guarantees, warrants, or endorses any product or service advertised in the Journal. Journal of Invasive and Clinical Cardiology follows the guidelines on editorial independence produced by the International Committee of Medical Journal Editors (ICMJE). All manuscripts correctly submitted to Journal of Invasive and Clinical Cardiology are first reviewed by the Editors. Manuscripts are evaluated according to their scientific merit, originality, validity of the material presented and readability. Some manuscripts are returned back to the authors at this stage if the paper is deemed inappropriate for publication in Journal of Invasive and Clinical Cardiology, if the paper does not meet the submission requirements, or if the paper is not deemed to have a sufficiently high priority. All papers considered suitable by the Editors for progress further in the review process, undergo peer review by at least two reviewers. If there is any gross discrepancy between the comments of two reviewers, it is sent to a third reviewer. Peer reviewers' identities are kept confidential; authors' identities are also not disclosed to the reviewers. Accepted articles are edited, without altering the meaning, to improve clarity and understanding. Decision about provisional or final acceptance is communicated within 8 weeks.

**E. Cover Letter**

The cover letter should outline the importance and uniqueness of the work. It should include the signed declaration from all authors on:

1. Category of manuscript (original research, review article, case report, cardiovascular image, letter to the Editor)
2. Statement that the material has not been previously published or submitted elsewhere for publication (this restriction does not apply to abstracts published in connection with scientific meetings.)
3. Transfer of copyright to Journal of Invasive and Clinical Cardiology upon the acceptance of the manuscript for publication
4. All authors have reviewed the article and agree with its contents
5. Information of any conflicts of interest (of any) of the authors
6. Sources of research support, if any, including funding, equipment, and drugs.

The cover letter should also include the mailing address, telephone and fax numbers, and e-mail address of the corresponding author.

**F. Manuscript Preparation**

The manuscripts should comply with the prescribed guidelines. It should be well organized and written in simple and correct English under appropriate headings. The abbreviations and acronyms should be spelled out when they occur first time.

The Introduction should address the subject of the paper. The Methods section should describe in adequate detail the laboratory or study methods followed and state the statistical procedures employed in the research. This section should also identify the ethical guidelines followed by the investigators with regard to the population, patient samples or animal specimens used. A statement should be made, where applicable, that their study conforms to widely accepted ethical principles guiding human research (such as the Declaration of Helsinki) and also that their study has been approved by a local ethics committee. The Results section should be concise and include pertinent findings and necessary tables and figures. The Discussion should contain conclusions based on the major findings of the study, a review of the relevant literature, clinical application of the conclusions and future research implications. Following the Discussion, Acknowledgements of important contributors and funding agencies may be given.

a. *Title page information*
    - Title. Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations where possible.
    - Author names and affiliations. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lowercase superscript letter immediately after the author's name and in front of the appropriate address. Provide the e-mail address of each author.
    - Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.

b. *Abstract*
A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. References should be avoided. Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

c. *Keywords*
Immediately after the abstract, provide a maximum of 5 keywords. Keywords should be the listed terms in the Medical Subject's Headings (MeSH) of the U.S. National Library of Medicine (NLM) available at: https://www.nlm.nih.gov/mesh.

d. *Abbreviations*
Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

**e.** *Acknowledgements*
Collate acknowledgements in a separate section at the end of the article before the references. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

f. *Units*
Follow internationally accepted rules and conventions: use the international system of units (SI). If other units are mentioned, please give their equivalent in SI. Generic rather than trade names of drugs should be used.

g. *Figures and graphics*
    - For graphics, a digital picture of 300 dpi or higher resolution in JPEG or TIFF format should be submitted.
    - Figures should be numbered consecutively according to the order in which they have been first cited in the text, if there is more than 1 figure. Each figure should be cited in the text.
    - Each figure/illustration should be provided with a suitable legend that includes enough information to permit its interpretation without reference to the text.
    - All photomicrographs should indicate the magnification of the prints.
    - When symbols, arrows, numbers or letters are used to identify parts of the illustrations, each one should be explained clearly in the legend.

h. *Tables*
Tables should be placed next to the relevant text in the article.

- Number tables consecutively in accordance with their appearance in the text. Each table should be cited in the text in Arabic numerals.
- Titles should be brief and a short or abbreviated heading for each column should be given.
- Explanatory matter should be placed in footnotes and not in the heading.
- Abbreviations in each table should be explained in footnotes.
- The data presented in a table should not be repeated in the text or figure.

i. *References*

The authors are responsible for the accuracy and completeness of the references and their citations in the text.

References should follow the standards summarized in the NLM's International Committee of Medical Journal Editors (ICMJE) Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals (ICMJE Recommendations), available at: http://www.icmje.org/recommendations/. The titles of journals should be abbreviated according to the style used for MEDLINE (www.ncbi.nlm.nih.gov/nlmcatalog/journals). Journals that are not indexed should be written in full.

- References should be numbered consecutively in the order in which they are first mentioned in the text.
- References in text, tables and legends should be identified by superscript Arabic numerals at the end of the sentence outside any punctuation. If several different studies or papers are cited within one sentence, the number should be placed where it will accurately identify the correct study.
- The names of authors in the text should concur with the reference list.
- References cited only in tables or in legends to figures should be numbered in accordance with a sequence established by the first identification in the text of the particular table or illustration.
- Abstracts as references may be used; "unpublished observations" and "personal communications" may not be used as references, although references to written, not oral, communications may be inserted (in parentheses) in the text.
- Papers accepted but not yet published may be included as references by adding "In press" after the journal name. Information from manuscripts submitted but not yet accepted should be cited in the text as "unpublished observations" (in parentheses).
- In general: All authors/editors should be listed unless the number exceeds six, when you should give six followed by "et al."

Examples of correct forms of references are given below:

**Articles in Journals** (see also *Journal article on the Internet*)

1. *Standard journal article*

   List the first six authors followed by et al.

   Halpern SD, Ubel PA, Caplan AL. Solid-organ transplantation in HIV-infected patients. N Engl J Med. 2002 Jul 25;347(4):284-7.

   More than six authors:

   Rose ME, Huerbin MB, Melick J, Marion DW, Palmer AM, Schiding JK, et al. Regulation of interstitial excitatory amino acid concentrations after cortical contusion injury. Brain Res. 2002;935(1-2):40-6.

2. *Organization as author*

   Diabetes Prevention Program Research Group. Hypertension, insulin, and proinsulin in participants with impaired glucose tolerance. Hypertension. 2002;40(5):679-86.

3. *Both personal authors and organization as author* (List all as they appear in the byline.)

   Vallancien G, Emberton M, Harving N, van Moorselaar RJ; Alf-One Study Group. Sexual dysfunction in 1,274 European men suffering from lower urinary tract symptoms. J Urol. 2003;169(6):2257-61.

4. *Volume with supplement*

   Geraud G, Spierings EL, Keywood C. Tolerability and safety of frovatriptan with short- and long-term use for treatment of migraine and in comparison with sumatriptan. Headache. 2002;42 Suppl 2:S93-9.

5. *Issue with supplement*

   Glauser TA. Integrating clinical trial data into clinical practice. Neurology. 2002;58(12 Suppl 7):S6-12.

6. *Type of article indicated as needed*

   Tor M, Turker H. International approaches to the prescription of long-term oxygen therapy [letter]. Eur Respir J. 2002;20(1):242.

   Lofwall MR, Strain EC, Brooner RK, Kindbom KA, Bigelow GE. Characteristics of older methadone maintenance (MM) patients [abstract]. Drug Alcohol Depend. 2002;66 Suppl 1:S105.

7. *Article published electronically ahead of the print version*

   Yu WM, Hawley TS, Hawley RG, Qu CK. Immortalization of yolk sac-derived precursor cells. Blood. 2002 Nov 15;100(10):3828-31. Epub 2002 Jul 5.

**Books and Other Monographs**

1. *Personal author(s)*

   Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical microbiology. 4th ed. St. Louis: Mosby; 2002.

2. *Editor(s), compiler(s) as author*

   Gilstrap LC 3rd, Cunningham FG, VanDorsten JP, editors. Operative obstetrics. 2nd ed. New York: McGraw-Hill; 2002.

3. *Organization(s) as author*

   Advanced Life Support Group. Acute medical emergencies: the practical approach. London: BMJ Books; 2001. 454 p.

4. *Chapter in a book*

   Meltzer PS, Kallioniemi A, Trent JM. Chromosome alterations in human solid tumors. In: Vogelstein B, Kinzler KW, editors. The genetic basis of human cancer. New York: McGraw-Hill; 2002. p. 93-113.

5. *Conference proceedings*

   Harnden P, Joffe JK, Jones WG, editors. Germ cell tumours V. Proceedings of the 5th Germ Cell Tumour Conference; 2001 Sep 13-15; Leeds, UK. New York: Springer; 2002.

6. *Dissertation or thesis*

   Borkowski MM. Infant sleep and feeding: a telephone survey of Hispanic Americans [dissertation]. Mount Pleasant (MI): Central Michigan University; 2002.

**Other Published Material**

*Newspaper article*

Tynan T. Medical improvements lower homicide rate: study sees drop in assault rate. The Washington Post. 2002 Aug 12;Sect. A:2 (col. 4).

**Unpublished Material**

*In press or Forthcoming*

Tian D, Araki H, Stahl E, Bergelson J, Kreitman M. Signature of balancing selection in Arabidopsis. Proc Natl Acad Sci U S A. Forthcoming 2002.

**Electronic Material**

1. *Journal article on the Internet*

Abood S. Quality improvement initiative in nursing homes: the ANA acts in an advisory role. Am J Nurs. 2002 Jun [cited 2002 Aug 12];102(6):[about 1 p.]. Available from: http://www.nursingworld.org/AJN/2002/june/Wawatch.htmArticle

Article published electronically ahead of the print version:

Yu WM, Hawley TS, Hawley RG, Qu CK. Immortalization of yolk sac-derived precursor cells. Blood. 2002 Nov 15;100(10):3828-31. Epub 2002 Jul 5.

Article with document number in place of traditional pagination:

Williams JS, Brown SM, Conlin PR. Videos in clinical medicine. Blood-pressure measurement. N Engl J Med. 2009 Jan 29;360(5):e6. PubMed PMID: 19179309.

Article with a Digital Object Identifier (DOI):

Zhang M, Holman CD, Price SD, Sanfilippo FM, Preen DB, Bulsara MK. Comorbidity and repeat admission to hospital for adverse drug reactions in older adults: retrospective cohort study. BMJ. 2009 Jan 7;338:a2752. doi: 10.1136/bmj.a2752. PubMed PMID: 19129307; PubMed Central PMCID: PMC2615549.

2. *Monograph on the Internet*

   Foley KM, Gelband H, editors. Improving palliative care for cancer [Internet]. Washington: National Academy Press; 2001 [cited 2002 Jul 9]. Available from: http://www.nap.edu/books/0309074029/html/.

3. *Homepage/Web site*

   Cancer-Pain.org [Internet]. New York: Association of Cancer Online Resources, Inc.; c2000-01 [updated 2002 May 16; cited 2002 Jul 9]. Available from: http://www.cancer- pain.org/.

**G. Submission Preparation Checklist**

As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.

1. The submission has not been previously published elsewhere, is original and has been written by the stated authors.
2. The article is not currently being considered for publication by any other journal and will not be submitted for such review while under review by the Bangladesh Heart Journal.
3. The submission file is in Microsoft Word file format, and the figures are in JEPG or TIFF format.
4. The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
5. The text adheres to the stylistic and bibliographic requirements outlined in the Instruction to Authors. Make sure that the references have been written according to the ICMJE Recommendations Style.
6. Spell and grammar checks have been performed.
7. All authors have read the manuscript and agree to publish it.

**H. Submission**

Papers should be submitted to the Editor. Three copies of manuscript should be submitted duly signed by all authors with a copy of CD, to:

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Ex-Director and Professor of Cardiology
National Institute of Cardiovascular Diseases
Sher E Bangla Nagar, Dhaka 1207, Bangladesh.

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# High Risk PCI in Women

**Anoop Titus[1], Sai Vikram Alampoondi[1], Ramesh Daggubati[2]**

**Abstract:**

Percutaneous Coronary Intervention (PCI) has been venturing into the population of high-risk which includes a large fraction of women. Cardiogenic Shock and Acute Myocardial infarction along with multiple other conditions have been presently included in the high-risk category for PCI. In the past, there had been no decline in post-myocardial infarction mortality. Women had been treated less aggressively and lacked involvement in multiple clinical trials regarding the use of interventional devices. It was also seen that treatment on women lacked following strict protocols. As a result, in-hospital mortality is higher in women in various conditions. Of those women classified as high-risk, CABG (regarded as the therapy providing complete revascularization) was often denied although eligible. Female sex was an independent risk factor for post-CABG mortality. Despite having a higher age-adjusted risk, they are equally likely as men to survive unto hospital discharge after PCI. High-risk PCI involving the use of Mechanical Circulatory support systems demonstrated higher rates of complications in women such as 'transfusion-requiring-bleeding' and earlier neurological events. Although, devices such as the Impella was shown to lower risk of repeat revascularization and provide better 90-day survival in non-emergent high-risk PCI, it also had a higher risk of bleeding events compared with the Intra-aortic balloon pump. Since women tend to have a higher rate of renal insufficiency, Impella allowed the support of the hemodynamics providing a renoprotective effect along with the leeway for higher rates of complete revascularization with PCI. Thus, in turn projected better survival.

**Conflict of interest statement:** The authors have no conflict of interest to declare.

**Key words:** high risk PCI; women; interventional cardiology

**J Inv Clin Cardiol 2021; 3(1): 1-9**

## Introduction:

Percutaneous coronary intervention (PCI) has advanced much in the recent ages with respects to techniques and devices that enable interventional cardiologists to operate not only on lower risk patients but also has ventured into patients at high-risk. The advancements in technology has progressed to an extent where Mechanical Circulatory Support (MCS) devices which once used to be a bridge-to-transplant, now is also a preferred destination therapy. The definition of 'high-risk' has also evolved to include clinical, hemodynamic and/or anatomic complexities. Complex high-risk indicated patients (CHIP) in commonness may include cases such as unprotected left main disease, last patent coronary conduit, patients of old-age, multi-vessel disease, severe coronary calcification, coronary vessel supplying a large myocardial territory with depressed ejection fraction (EF), concomitant cardiac, pulmonary or nephrological comorbidities[1].

Ischemic heart disease is the leading cause for both mortality and morbidity irrespective of gender[2]. On the other hand, cardiogenic shock (CS) implies a state of hypotension due to low cardiac output resulting in tissue hypoxia and hypoperfusion. The two most common causes of CS are acute myocardial infarction (AMI - approximately 80% with acute left ventricular failure) and cardiac arrest (CA). Patients with cardiogenic shock suffer from high mortality and survivors have high morbidity[3]. Patients with high risk, especially those with cardiogenic shock, require the use of mechanical circulatory support (MCS) so as to maximally normalize hemodynamics[4]. There are 3 types of MCS devices- LVADs (Impella, Tandem Heart, HeartMate) IABP and

1. Saint Vincent Hospital, Worcester, MA

2. Heart and Vascular Institute West Virginia University, Morgantown, WV

**Address of Correspondence:** Dr. Ramesh Daggubati, MD, FACC, FSCAI, Associate Chief of Cardiology, Heart & Vascular Institute, West Virginia University School of Medicine, 1 Medical Center Drive, Morgantown, WV 26505, Fax: 304-285-1986, Phone: +15163857248, email: daggur@yahoo.com

ECMO. Their main function is to maintain or improve cardiac output in patients undergoing PCI[5]. Of these, the Impella and IABP has been scrutinized in the past with the hope of improving mortality. Clinical trials and various studies have shown highly variable results over time, which also would be focused in this article.

**Background:**

In the past, amongst the patients with acute coronary syndromes (ACS) - which is 625,000 people per year - about 262,000 were women (2017)[6]. There has been no decline in post-Myocardial infarction mortality in women when comparing the period 2001-2003 and 2007-2009. Women have been treated less aggressively compared to men in the treatment of acute coronary syndromes[7]. In 2005, the CRUSADE study, it was shown that women who experience NSTEMI, have taken longer time from symptom onset to presentation, and are less likely to perform the first electrocardiogram within 10 minutes of presentation. Also, compared to men, there is evidence that women have higher unadjusted mortality, early intervention, reperfusion therapy and are provided lesser thienopyridines and glycoprotein inhibitors use[8-9]. Today, in-hospital mortality is higher in women presenting with both STEMI and N-STEMI[10]. Female sex is known to have higher mortality, lesser guideline-directed care and eligible reperfusion rates[11]. Ventricular assist devices are far less likely used or included in trials on women compared to men, despite the similar prevalence of eligibility. Over the years, it can be assumed that it has been negated with improved ischemia to door to balloon times[7]. Hence it is of great significance to magnify and review the impact of PCI in women categorized as high-risk.

**Mechanical Circulatory Support (MCS) devices:**

Technological development, increasing operator skill, ease of use, exploring the boundaries of indications of patients have expanded the use of MCS devices in PCI. Due to this, there has been an increasing trend with the use of MCS[12]. The use of mechanical circulatory systems increased from 2.5% of all PCI procedures in 2008, to about 3.5% in 2016. And along with it, in-hospital mortality with LVAD implantation decreased significantly from 47.2% to 12.7% in the period 2005 to 2011[11]. Despite the high rates of debilitation caused by CS as a successor of MI, in 2011 it was shown that there is a paucity of sex-specific safety, effectiveness, and outcomes data for mechanical support in the setting of CS, particularly prior to FDA approval[13]. Most studies lack female participants.

Prior reports from registries concerning use of LVADs from 2015 INTERMACS had demonstrated a higher mortality in the female sex[14]. Recent studies, 2019 INTERMACS has no such evidence demonstrating gender-disparity in mortality rates - thus hinting better outcomes with newer LVAD utilization[11]. Although with promising results, the European Registry for Patients with Mechanical Circulatory Support (EUROMACS) noted that significantly more male patients received MCS compared to women. In the EUROMACS Registry (2011 to 2014) the need for right ventricular support was significantly more in women than men. There was significantly inferior survival rate in women vs. men in 1-year, 2-year and 3-year survival. This urges the need for better implementation of appropriate management protocols for women[15].

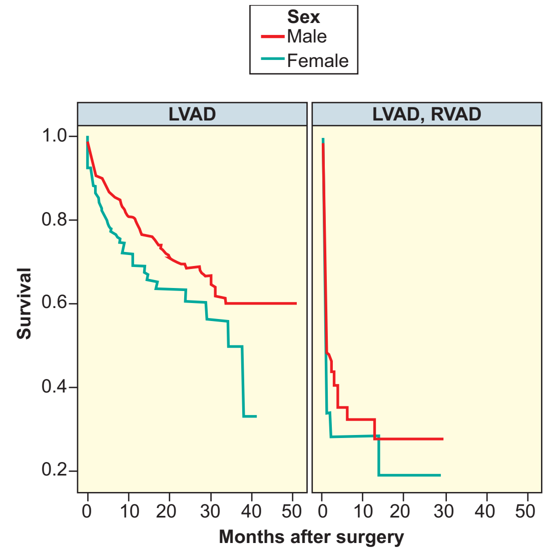


**Fig.-1:** *Post-operative gender specific survival on LVAD and BIVAD based on the EUROMACS registry*

**Devices:**

*Impella:*

*Mechanism*

Impella (Abiomed Inc., Danvers, Massachsetts) is a device that is positioned across the aortic valve. During diastole, it flushes out the blood from the left ventricle so as to reduce diastolic wall stress, increasing the aortic and coronary pressures, simultaneously reducing coronary microvascular resistance. This allows recovery of stunned or hibernating myocardium. There are multiple variants of the device - Impella 2.5™

(pumps 2.5 l/min), Impella 5.0™ (pumps 2.5 l/min), Impella CP™ (pumps 4.0 l/min)[16].

**Intra-aortic balloon pump:**

*Mechanism*

There are two principles by which IABP allows assistance to the left ventricular functioning by alternating inflation and deflation situated inside the aorta - diastolic augmentation and systolic unloading [17-18]. There occurs an increase in the aorto-coronary pressure gradient which allows higher flow of blood into the coronaries. Multiple studies have demonstrated highly variable results, such as no increase in coronary blood flow (CBF)[19] in opposition to some studies demonstrating increase in distal blood flow[20]. This works by inflation of balloon in the aorta during aortic valve closure, thus propelling blood into coronaries and distal aorta. Consequential active deflation of the balloon during isovolumetric contraction such as to assist the ventricle by reducing the oxygen demand[15].

**Tandem heart:**

*Mechanism*

The Tandem Heart is a percutaneously placed device where one end is penetrated into the femoral vein, passed via a transseptal perforation to the left atrium. The other end is placed into the aortic bifurcation via the femoral artery. This allows a bypass for blood from the left heart to the circulatory system hence reducing the workload and thus reducing oxygen demand of the myocardium. The flow rate achieved by this device of about ~4 l/min improves cardiac index, mean arterial pressure, reduces pulmonary capillary wedge pressure by the reduced filling of both ventricles[15,21].

**Extracorporeal membrane oxygenation:**

*Mechanism*

Extracorporeal membrane oxygenation (ECMO) takes blood from the venous circulation and oxygenates it to deliver the blood to the arterial circulation. It is the only type of MCS which oxygenates the blood. Contrastingly, it causes an increase in LV after load and thus raising the myocardial oxygen requirements. One of the pre-requisites is the necessity for anti-coagulation with heparin while setting up the ECMO[15]. Conditions such as severe aortic stenosis, bleeding diathesis, stroke, recent hemorrhage, and uncontrolled sepsis contraindicates against ECMO[22].

**Review:**

*High-Risk PCI:*

The definition of high-risk PCI is ever-evolving and is yet to obtain a concrete form. At present, many parameters are set to form an inclusive criterion by a consensus by American College of Cardiology 2015. There are many reasons why women have a higher cardiac mortality compared to men of the same age. They include - smaller coronary arteries[23-24], abnormal coronary reactivity, microvascular dysfunction, pre-disposition to plaque erosion and distal embolization. A study by Campbell et al showed that women had higher arteriolar wall thickness and diffusion radius[25].

Women classified under high-risk have higher co-morbidities and hence higher mortality with CABG when compared to males with the same *STS* (Society of Thoracic Surgeons) scores[26]. In a study to analyze sexual dimorphism in outcomes of those undergoing coronary angiography and percutaneous coronary intervention by the German Society of Cardiology, 2017, demonstrated that women have a 20% higher age-adjusted risk of death and of ischemic cardiac and cerebrovascular events. Women who have MI more often sustain a cardiac arrest compared to men. Higher rates of arrhythmias and peripheral artery embolisms are seen in women.

Despite such complications, and seeding high in the high-risk category, they are equally likely as men to survive unto hospital discharge after PCI[27]. Earlier in 2004, that was not the case, as women with MI had higher in-hospital mortality compared to men[28-39]. Exploring the reasons, women with STEMI developed more CS compared to men. Despite that, intervention with protected PCI using Impella, women demonstrated an equal likelihood of survival compared to men when instituted early in the treatment. It is also seen that women also were more often in cardiogenic shock at the time of MCS implantation compared to men, although, contrastingly studies show highly variable results both with lower or similar survival to males[30].

**Procedural Bleeding**

Women tend to have a higher chance of developing 'transfusion-requiring-bleed' after PCI, when compared to males[11]. In a study in 2015, women were seen to have higher re-operations for bleeding complications[16]. In a meta-analysis done recently, it was seen that LVADs resulted in increased bleeding complications compared to IABP[31]. This is speculated due to their larger sheaths and more complex operations. Hence DAPT or anticoagulation after PCI must be monitored well to prevent such complications.

### Metaanalysis and Other Studies Equating Impella to Iabp

A recent meta-analysis by Wenhai et al. (2019) from Baltimore demonstrates that neither IABP nor LVADs used in patient undergoing high-risk PCI, improved survival of patients over 30 days and 6 months (RR 0.96 95% CI 0.71–1.29; RR 1.23 95% CI 0.88–1.72) respectively [31]. Although, LVADs does reduce repeat revascularization (RR 0.26 95% CI 0.08–0.83), there was an increased risk of bleeding events compared to IABP (RR 2.85 95% CI 1.72–4.73). The PROTECT II Trial (2012) demonstrated that there is no mortality difference between Impella 2.5 and IABP during high-risk PCI in 30-day or 90-day mortality. On the contrary, in 90-day survival, Impella 2.5™ outshone IABP depicting better survival trends when applied in non-emergent high-risk PCI[32]. There were fewer rates of irreversible MACCE, death/stroke/MI/repeat revascularization the Impella 2.5 arm vs. that of IABP. This is essential to know, as LVADs demonstrate a higher risk in women to develop the first neurological event (1.44; 95% CI, 1.05–1.96; P=0.020)[30]. In 2013, use of IABP has been downgraded from Class I to a Class IIa recommendation due to no mortality benefit in early (30-day) post-infarct period in the Intra-aortic Balloon Pump Support for Myocardial Infarction with Cardiogenic Shock (IABP-SHOCK II) Trial.

### No-Difference In Genders - Impella

A study was conducted in 2017 on 160 patients who were not in cardiogenic shock - with Impella 2.5 or Impella CP as the device of choice - for patients who were having an EF <35% additionally with another criteria of inclusion which included the use of atherectomy device, unprotected left main disease or multi-vessel disease. It was seen that there is no-difference in clinical outcomes between the genders. A study on the cVAD registry with 180 patients showed that women were better beneficiaries than men to the use of the Impella 2.5 as pre-PCI. It was associated with a greater survival benefit to hospital discharge in women compared to men, despite a higher predicted risk of mortality and a greater revascularization failure rate for women. Overall, pre-PCI use of Impella produced lesser mortality rates than those who received a post-PCI support[27]. This supported early initiation of hemodynamic support prior to PCI with Impella 2.5, in the setting of AMI complicated by CS. With the knowledge that women are at a higher risk of developing CS than men after STEMI, this evidence affirms to funnel the guidelines to the use of Impella 2.5 in women prior to PCI to obtain better survival. A study of 19,278 all comer patients including 5456 women in whom Impella was used showed that women suffered higher morbidity and mortality in high-risk group but not in the cardiogenic shock group[46]. Weighing it with the evidence that women have higher bleeding risk compared to men with Impella use, the interventionist must decide between Impella and the IABP when considering bleeding, as it is one of the common causes of re-operation in women.

### Significance Of Revascularization:

Complete revascularization is best achieved with CABG, that provides the most long-term mortality benefits when done in eligible patients[33-34]. Unfortunately, complex high-risk indicated patients are more likely excluded from the CABG procedure due to other associated comorbidities, CAD severity and low ventricular function. Protected PCI is considered equally as safe as CABG. The female gender as such is an independent risk factor for mortality post-CABG[35-36]. Considering gender, it is seen that more of the female sex was turned down from proceeding into CABG due to the higher prevalence of comorbidities. These patients would require hemodynamic support at the time of PCI[42-44]. Thus, from the meta-analysis by Wenhai et al., the hemodynamic support using LVADs would be advisable to prevent revascularization in those women opting CABG.

Moreover, with the use of Impella, it was observed that more vessels were able to be treated, more stents used and enabled the use of atherectomy for plaque modification. This is enabled by their powerful hemodynamic support[32,38]. In eventuality, this function of the Impella in turn accommodates the leeway to perform complete revascularization through PCI. Complete revascularization has shown to have better clinical outcomes than incomplete revascularization. Historically, success rate of revascularization as such is lower in women[27]. There is no difference in clinical outcomes between males and women in in-hospital mortality and 30-day survival rates when performing revascularization in the setting of LVADs[39]. In view of complete revascularization, CvLPRIT, ACUITY and PRIMULTI trials supported complete revascularization for improved outcomes. A meta-analysis by Gaffar et al. done also suggests the use of single setting complete revascularization in acute coronary syndrome[39-41].

## Renal

Women generally tend to have a higher rate of renal insufficiency compared to males-with-high-risk at baseline. The use of Impella allows to maintain appropriate perfusion to coronary and renal vessels, thus supporting hemodynamics. This helps to reduce the incidence of acute kidney injury. It will sustain its renoprotective effect inclusive in the presence of an underlying chronic kidney disease or reducing ejection fraction[11,42].

## Device disparity: Impella vs. IABP

IABP counter pulsation and Impella has been compared and contrasted in various trials in the past. A higher cardiac index was seen in the Impella Group vs. the IABP group in the ISAR-SHOCK trial (2008)[43]. The SHOCK Trial registry depicted that cardiac power (i.e., the rate of energy input the systemic vasculature receives from the heart at the level of the aortic root, which represents the energy available to perfuse vital organs) must considered to the most important predictors for the outcome for patients with CS undergoing PCI.

Tandem Heart demonstrated no mortality benefit seen in the 30-day mortality when patients with CS were randomized to Tandem Heart and IABP[44].

## Conclusion:

With the under-representation of women in clinical studies and lack of adherence to strict treatment protocols when deployed on female patients, it calls for the need to shed light on the advances in interventions among them in High-risk PCI. As women have higher age-adjusted risk and are often deferred from CABG, PCI stand the most opted route of treatment for most of them. The use of MCS shows better outcomes in women when compared to males. The use of Impella not only allows for compensating the hemodynamic chasm, but also allows higher rates of complete revascularization with PCI, hence offering better survival. Bleeding and neurological events do pose a risk higher in women than men. IABP offers a lesser risk of post-procedural bleeding when compared to Impella. Lastly, predictors such as cardiac power must be used in high-risk patients with cardiogenic shock prior to PCI for better outcomes.

## References:


1. Levine GN, Bates ER, Blankenship JC, Bailey SR, Bittl JA, Cercek B, et al. 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Society for Cardiovascular Angiography and Interventions. Circulation [Internet]. 2011 [cited 2019 Oct 14];124(23):e574-651. Available from: https://www.ncbi.nlm.nih.gov/pubmed/22064601
2. Ratnaparkhi D, Mahajan T, Jadhav V. Heart disease prediction system using data mining technique. Int Res J Engine Technol (IRJET). 2015;2 (08):2395-0056.
3. Wernly B, Seelmaier C, Leistner D, Stähli BE, Pretsch I, Lichtenauer M, et al. Mechanical circulatory support with Impella versus intra-aortic balloon pump or medical treatment in cardiogenic shock—a critical appraisal of current data. Clinical Research in Cardiology. 2019 Mar 21;108(11):1249–57.
4. Briasoulis A, Telila T, Palla M, Mercado N, Kondur A, Grines C, et al. Meta-Analysis of Usefulness of Percutaneous Left Ventricular Assist Devices for High-Risk Percutaneous Coronary Interventions. The American Journal of Cardiology. 2016 Aug;118(3):369–75.
5. Dixon SR, Henriques JPS, Mauri L, Sjauw K, Civitello A, Kar B, et al. A Prospective Feasibility Trial Investigating the Use of the Impella 2.5 System in Patients Undergoing High-Risk Percutaneous Coronary Intervention (The PROTECT I Trial). JACC: Cardiovascular Interventions. 2009 Feb;2(2):91–6.
6. Benjamin EJ, Blaha MJ, Chiuve SE, Cushman M, Das SR, Deo R, et al. Heart Disease and Stroke Statistics—2017 Update: A Report From the American Heart Association. Circulation [Internet]. 2017 Mar 7;135(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5408160/
7. Blomkalns AL, Chen AY, Hochman JS, Peterson ED, Trynosky K, Diercks DB, et al. Gender disparities in the diagnosis and treatment of non–ST-segment elevation acute coronary syndromes. Journal of the American College of Cardiology. 2005 Mar;45(6):832–7.
8. Glaser R. Benefit of an Early Invasive Management Strategy in Women With Acute Coronary Syndromes. JAMA. 2002 Dec 25;288(24):3124.
9. Gharacholou SM, Alexander KP, Chen AY, Wang TY, Melloni C, Gibler WB, et al. Implications and reasons for the lack of use of reperfusion therapy in patients with ST-segment elevation myocardial infarction: Findings from the CRUSADE initiative. American Heart Journal. 2010 May;159(5):757–63.
10. Virani SS, Alonso A, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, et al. Heart Disease and Stroke Statistics—2020 Update. Circulation. 2020 Jan 29;141(9).
11. Alraies MC, Kaki A, Kajy M, Blank N, Hasan R, Htun WW, et al. Sex related difference in the use of percutaneous left ventricular assist device in patients undergoing complex high risk percutaneous coronary intervention: Insight from the cVAD registry. Catheterization and Cardiovascular Interventions. 2019 Oct 21;

12. Khera R, Cram P, Vaughan-Sarrazin M, Horwitz PA, Girotra S. Use of Mechanical Circulatory Support in Percutaneous Coronary Intervention in the United States. The American Journal of Cardiology. 2016 Jan;117(1):10–6.

13. Dhruva SS, Bero LA, Redberg RF. Gender Bias in Studies for Food and Drug Administration Premarket Approval of Cardiovascular Devices. Circulation: Cardiovascular Quality and Outcomes. 2011 Mar;4(2):165–71.

14. Kirklin JK, Naftel DC, Pagani FD, Kormos RL, Stevenson LW, Blume ED, et al. Seventh INTERMACS annual report: 15,000 patients and counting. The Journal of Heart and Lung Transplantation [Internet]. 2015 Dec [cited 2019 Jul 18];34(12):1495–504. Available from: https://www.sciencedirect.com/science/article/pii/S1053249815014503

15. Bernhardt AM, Sill B, Wagner FM, deBy TM, Gummert J, Mohacsi P, et al. Gender Differences in Mechanical Circulatory Support - Insights From a European Registry. The Journal of Heart and Lung Transplantation. 2015 Apr;34(4):S25.

16. Myat A, Patel N, Tehrani S, Banning AP, Redwood SR, Bhatt DL. Percutaneous Circulatory Assist Devices for High-Risk Coronary Intervention. JACC: Cardiovascular Interventions. 2015 Feb;8(2):229–44.

17. Yoshitani H, Akasaka T, Kaji S, Kawamoto T, Kume T, Neishi Y, et al. Effects of intra-aortic balloon counterpulsation on coronary pressure in patients with stenotic coronary arteries. American Heart Journal. 2007 Oct;154(4):725–31.

18. Rh C, Wc B, G A, S L, Wj T, Am F, et al. Assisted Circulation. I. The Arterial Counterpulsator [Internet]. The Journal of thoracic and cardiovascular surgery. 1961 [cited 2020 Jun 7]. Available from: https://pubmed.ncbi.nlm.nih.gov/13693965/

19. Kern MJ, Aguirre F, Bach R, Donohue T, Siegel R, Segal J. Augmentation of coronary blood flow by intra-aortic balloon pumping in patients after coronary angioplasty. Circulation. 1993 Feb;87(2):500–11.

20. Takeuchi M, Nohtomi Y, Yoshitani H, Miyazaki C, Sakamoto K, Yoshikawa J. Enhanced coronary flow velocity during intra-aortic balloon pumping assessed by transthoracic doppler echocardiography. Journal of the American College of Cardiology. 2004 Feb;43(3):368–76.

21. Kar B, Gregoric ID, Basra SS, Idelchik GM, Loyalka P. The Percutaneous Ventricular Assist Device in Severe Refractory Cardiogenic Shock. Journal of the American College of Cardiology. 2011 Feb;57(6):688–96.

22. Ha J, Dr K, M G, Dj M, S G. Left Ventricular Assist for High-Risk Percutaneous Coronary Intervention [Internet]. The Journal of invasive cardiology. 2012 [cited 2020 Jun 7]. Available from: https://pubmed.ncbi.nlm.nih.gov/23043040/

23. Sheifer SE, Canos MR, Weinfurt KP, Arora UK, Mendelsohn FO, Gersh BJ, et al. Sex differences in coronary artery size assessed by intravascular ultrasound. American Heart Journal. 2000 Apr;139(4):649–52.

24. Dickerson JA, Nagaraja HN, Raman SV. Gender-Related Differences in Coronary Artery Dimensions: A Volumetric Analysis. Clinical Cardiology. 2009 Dec 30;33(2):E44–9.

25. Campbell DJ, Somaratne JB, Jenkins AJ, Prior DL, Yii M, Kenny JF, et al. Differences in Myocardial Structure and Coronary Microvasculature Between Men and Women With Coronary Artery Disease. Hypertension. 2011 Feb;57(2):186–92.

26. Levine GN, Bates ER, Blankenship JC, Bailey SR, Bittl JA, Cercek B, et al. 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention: Executive Summary. Circulation. 2011 Dec 6;124(23):2574–609.

27. Joseph SM, Brisco MA, Colvin M, Grady KL, Walsh MN, Cook JL. Women With Cardiogenic Shock Derive Greater Benefit From Early Mechanical Circulatory Support: An Update From the cVAD Registry. Journal of Interventional Cardiology. 2016 May 26;29(3):248–56.

28. Zeymer U. Predictors of in-hospital mortality in 1333 patients with acute myocardial infarction complicated by cardiogenic shock treated with primary percutaneous coronary intervention (PCI) Results of the primary PCI registry of the Arbeitsgemeinschaft Leitende Kardiologische Krankenhausärzte (ALKK). European Heart Journal. 2004 Feb;25(4):322–8.

29. Antoniucci D, Migliorini A, Moschi G, Valenti R, Trapani M, Parodi G, et al. Does gender affect the clinical outcome of patients with acute myocardial infarction complicated by cardiogenic shock who undergo percutaneous coronary intervention? Catheterization and Cardiovascular Interventions. 2003 Jul 25;59(4):423–8.

30. Hsich EM, Naftel DC, Myers SL, Gorodeski EZ, Grady KL, Schmuhl D, et al. Should Women Receive Left Ventricular Assist Device Support? Circulation: Heart Failure. 2012 Mar;5(2):234–40.

31. Shi W, Wang W, Wang K, Huang W. Percutaneous mechanical circulatory support devices in high-risk patients undergoing percutaneous coronary intervention. Medicine. 2019 Sep;98(37):e17107.

32. O'Neill WW, Kleiman NS, Moses J, Henriques JPS, Dixon S, Massaro J, et al. A Prospective, Randomized Clinical Trial of Hemodynamic Support With Impella 2.5 Versus Intra-Aortic Balloon Pump in Patients Undergoing High-Risk Percutaneous Coronary Intervention. Circulation. 2012 Oct 2;126(14):1717–27.

33. Coronary artery bypass surgery versus percutaneous coronary intervention with stent implantation in patients with multivessel coronary artery disease (the Stent or Surgery trial): a randomised controlled trial. The Lancet. 2002 Sep;360(9338):965–70.

34. Kang SH, Lee CW, Yun S-C, Lee PH, Ahn J-M, Park D-W, et al. Coronary Artery Bypass Grafting vs. Drug-Eluting Stent Implantation for Multivessel Disease in Patients with Chronic Kidney Disease. Korean Circulation Journal. 2017;47(3):354.

35. Becher T, Baumann S, Eder F, Perschka S, Loßnitzer D, Fastner C, et al. Comparison of peri and post-procedural

complications in patients undergoing revascularisation of coronary artery multivessel disease by coronary artery bypass grafting or protected percutaneous coronary intervention with the Impella 2.5 device. European Heart Journal: Acute Cardiovascular Care. 2017 Jun 29;8(4): 360–8.

36. R B, Rp W, M A, B J, Yb L, M P. Female Gender Is an Independent Predictor of Operative Mortality After Coronary Artery Bypass Graft Surgery: Contemporary Analysis of 31 Midwestern Hospitals [Internet]. Circulation. 2005 [cited 2020 Jun 7]. Available from: https://pubmed.ncbi.nlm.nih.gov/16159840/

37. Rihal CS, Naidu SS, Givertz MM, Szeto WY, Burke JA, Kapur NK, et al. 2015 SCAI/ACC/HFSA/STS Clinical Expert Consensus Statement on the Use of Percutaneous Mechanical Circulatory Support Devices in Cardiovascular Care. Journal of the American College of Cardiology. 2015 May;65(19):e7–26.

38. Vetrovec GW. Hemodynamic Support Devices for Shock and High-Risk PCI: When and Which One. Current Cardiology Reports. 2017 Aug 31;19(10).

39. Doshi R, Singh A, Jauhar R, Meraj PM. Gender difference with the use of percutaneous left ventricular assist device in patients undergoing complex high-risk percutaneous coronary intervention: From pVAD Working Group. European Heart Journal: Acute Cardiovascular Care. 2018 Jan 8;8(4):369–78.

40. Gaffar R, Habib B, Filion KB, Reynier P, Eisenberg MJ. Optimal Timing of Complete Revascularization in Acute Coronary Syndrome: A Systematic Review and Meta Analysis. Journal of the American Heart Association. 2017 Apr 5;6(4).

41. Vaidya SR, Devarapally SR, Arora S. Infarct related artery only versus complete revascularization in ST-segment elevation myocardial infarction and multi vessel disease: a meta-analysis. Cardiovascular Diagnosis and Therapy. 2017 Feb;7(1):16–26.

42. [42] Flaherty MP, Pant S, Patel SV, Kilgore T, Dassanayaka S, Loughran JH, et al. Hemodynamic Support With a Microaxial Percutaneous Left Ventricular Assist Device (Impella) Protects Against Acute Kidney Injury in Patients Undergoing High-Risk Percutaneous Coronary Intervention. Circulation Research. 2017 Feb 17;120(4):692–700.

43. Seyfarth M, Sibbing D, Bauer I, Fröhlich G, Bott-Flügel L, Byrne R, et al. A Randomized Clinical Trial to Evaluate the Safety and Efficacy of a Percutaneous Left Ventricular Assist Device Versus Intra-Aortic Balloon Pumping for Treatment of Cardiogenic Shock Caused by Myocardial Infarction. Journal of the American College of Cardiology. 2008 Nov;52(19):1584–8.

44. Thiele H, Sick P, Boudriot E, Diederich K-W, Hambrecht R, Niebauer J, et al. Randomized comparison of intra-aortic balloon support with a percutaneous left ventricular assist device in patients with revascularized acute myocardial infarction complicated by cardiogenic shock. European Heart Journal. 2005 Feb 25;26(13):1276–83.

ORIGINAL ARTICLE

# The Impact of Preoperative Anaemia on Early Outcomes after Off-pump Coronary Artery Bypass Grafting

**Sanjay Kumar Raha[1], Smriti Kana Biswas[2], Sorower Hossain[3], Md Salahuddin Rahaman[4], Khan Muhammad Fahim Bin Enayet[5], Md Kamrul Hasan[6]**

## Abstract:

**Introduction:** In cardiac surgery, anaemia itself or combined with other risk factors has been found to be a major predictor for adverse outcome both preoperatively and postoperatively and even during extracorporeal circulation, but data about the specific tolerance of Coronary Artery Bypass Graft (CABG) patients for anaemia are conflicting and may in part be confounded by the effects of bypass surgery.

**Objectives:** This study was performed in the National Institute of Cardiovascular Diseases (NICVD) to observe whether the early outcomes of Off-Pump CABG (OPCAB) were affected by pre-operative haematocrit levels.

**Methods:** A total of 200 patients who underwent isolated OPCAB between January 2015 and December 2020 were retrospectively selected and purposively allocated into two groups: a) 100 patients having preoperative anaemia and b) 100 patients without preoperative anaemia. Pre-operative, per-operative and early post-operative variables were recorded, compiled and compared.

**Results:** Preoperative characteristics were homogenously distributed between two groups other than haemoglobin level. Female patients had lower haemoglobin in each group. More patients of anaemic group required intraoperative and postoperative blood transfusion. The amount of blood loss and transfused blood products was also higher in anaemic patients. The ventilation time, length of ICU and post-operative hospital stay were significantly higher among anaemic patients. Among the post-operative complications, only the incidence of renal dysfunction was significantly higher among anaemic patients.

**Conclusion:** This study has showed that anaemic patients undergoing OPCAB had an increased risk of post-operative adverse events. Importantly, the extent of pre-existing comorbidities substantially affected perioperative anaemia tolerance. Therefore, pre-operative risk assessment, optimization and subsequent therapeutic strategies, such as blood transfusion, should take into account both the individual level of preoperative haemoglobin and the extent of concomitant risk factors.

**Key Words:** Anaemia, preoperative, OPCAB.

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## Introduction:

Coronary artery bypass surgery (CABG) is the most effective method for the treatment of ischemic heart disease[1]. The success of surgery depends to some extend on the elimination or improvement of risk factors or on taking measures against it. Some of these factors include advanced age, poor ventricular function, presence of diffuse coronary lesions, presence of poor respiratory or renal function, previous cardiac surgery, complicated surgery, and emergent surgical intervention[2].

1. Associate Professor, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases NICVD, Dhaka, Bangladesh.
2. Medical Officer, 250 Bedded TB Hospital, Shyamoli, Dhaka, Bangladesh.
3. Assistant Registrar, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases NICVD, Dhaka, Bangladesh.
4. Assistant Registrar, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases NICVD, Dhaka, Bangladesh.
5. Assistant Registrar, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases NICVD, Dhaka, Bangladesh.
6. Professor, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases NICVD, Dhaka, Bangladesh.

**Address of Correspondence:** Dr. Sanjay Kumar Raha, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases NICVD, Dhaka-1207, Bangladesh. E-mail: drsanjayraha77yahoo.com, Contact: +8801720988629.

Low haemoglobin is progressively frequent sign in patients having coronary heart disease[3]. About 51.5% patients with acute coronary syndrome in Indian population are anaemic[4]. Similar prevalence of anaemia is expected in our population with ischemic heart disease. World Health Organization (WHO) defined anaemia as haemoglobin level <13 gm/dl for adult male and <12 gm/dl for adult female[5].

Although anaemia is a potentially treatable condition prior to surgery, numerous studies have proved that low haemoglobin level is linked with higher rate of post-operative morbidity (specially renal and neurologic events) and mortality in patients suffering from congestive heart failure, ischemic heart disease particularly in acute coronary syndrome and in elderly population[3,6,7]. Diseased heart cannot raise cardiac output sufficiently; therefore, reduced level of haemoglobin, even when fully saturated, cannot supply enough oxygen throughout body. In theory, patients with coronary artery disease may tolerate anaemia well as long as the compensating mechanisms of the cardiovascular system are largely uncompromised and no extensive comorbidity exists[6]. The impact of anaemia is confounded by blood transfusion during and after cardiac surgery. Blood transfusion increases postoperative morbidity and mortality. Anaemic patients need more blood transfusion[8]. Several studies have found that, compared to non-anaemic patients, anaemic patients have significantly higher rate of operative mortality, prolonged ventilation, post-operative atrial fibrillation, post-operative renal dysfunction, stroke, deep sternal wound infection, perioperative blood transfusion, longer ICU stay and longer hospital stay after cardiac surgery[7,8,9,10,11].

The commonly applied preoperative risk stratification models in cardiac surgery like EuroSCORE, STS, ACEF, do not realize preoperative low haemoglobin level as a possible predictor of unfavorable outcomes and two out of nineteen models of risk stratification admit anaemia as an unconventional predictor of mortality[3,12,13,14]. Data from previous reports have disclosed preoperative anaemia to be self-sufficient predictor of unlucky outcomes in the form of morbidity and in-hospital death after coronary artery bypass graft (CABG) or valve surgery[3,8,15].

Use of cardiopulmonary bypass during coronary artery bypass graft surgery has many adverse effects. Moreover, cardiopulmonary bypass increases the effect of anaemia and blood transfusion[16]. Blood transfusion is usually required to increase haematocrit after weaning from cardiopulmonary bypass. Off-pump coronary artery bypass graft (OPCAB) surgery is a technique that avoids the adverse effects of cardiopulmonary bypass. There is evidence that OPCAB significantly reduces blood transfusion than on-pump coronary artery bypass grafting[17]. So, in case of OPCAB surgery, impact of preoperative low haemoglobin level is minimally affected by blood transfusion and not affected by cardiopulmonary bypass.

The aim of this study was to investigate whether the routinely measured preoperative haematocrit level, affects early postoperative outcomes after OPCAB surgery.

**Materials and Methods:**

This retrospective observational study was performed in the department of Cardiac Surgery, National Institute of Cardiovascular Diseases (NICVD) from January 2015 and December 2020. 200 purposively selected patients who underwent elective off pump coronary artery bypass (OPCAB) graft surgery were allocated into two groups:

Group A: 100 patients having preoperative anaemia (haemoglobin level 9 to 13 gram/dl for male and 9 to 12 gram /dl for female).

Group B: 100 patients without preoperative anaemia (haemoglobin level 13 to 16 gram/dl for male and 12 to 15 gram /dl for female).

**Technique of OPCAB:**

Haemoglobin estimation was done within one week prior to surgery. All patients underwent standard off pump coronary artery bypass (OPCAB) graft surgery through median sternotomy. The internal thoracic artery, the radial artery, and the saphenous vein were harvested as appropriate with standard techniques. Then intravenous heparin (100IU/ kg) was given to maintain an ACT of 300 second before starting distal anastomoses. Regional myocardial immobilization was achieved with a suction stabilizer (Octopus) and apical suction device (Star Fish). Intracoronary shunts were used in most patients to maintain coronary flow, thereby reducing myocardial ischemia and at the same time minimizing bleeding from the coronary arteriotomy. The left anterior descending (LAD) artery was revascularized first using left internal mammary/ thoracic artery (LIMA/ LITA). Proximal anastomoses were performed on the partially clamped ascending aorta using 6-0 continuous Prolene suture. Distal anastomoses were performed with continuous 7-0 or 8-0 polypropylene (Prolene) monofilament suture. After the procedure, heparin therapy was reversed with protamine sulfate in a 1:1 ratio. The leg, forearm, and chest wounds were closed and the patients were shifted to ICU. Total operation time and number of grafts were recorded.

**Postoperative Management:**
After surgery, all patients were transferred to the intensive care unit (ICU). Cardiac, respiratory, renal function and hourly blood loss were monitored meticulously. Extubation was done as early as possible while the patients fulfill the extubation criteria. Arterial blood gas, serum electrolytes and hematocrit estimation were done as per standard protocol. Haemodynamic and other parameters were managed according to standard protocol. Blood transfusion trigger was haematocrit of <26% or according to unit protocol. The amounts of transfused blood or blood products were recorded. Serum creatinine was measured daily up to third postoperative day. Patients were on continuous ECG monitoring for 5 days and a check ECG was done prior to discharge to detect any arrhythmia. Neurological assessments were done on the first and second postoperative day.

**Data Collection:**
Data were collected using predesigned questionnaire and collection form. Data were analyzed and verified with statistical program for social sciences (SPSS) using student's t test, chi-square test, fisher's exact test where appropriate. The descriptive statistics used here were frequency, mean and standard deviation (SD) and compared using student's t test. Categorical data were expressed as percentages and evaluated using chi-square or Fisher's exact probability test. The level of significance was 0.05. Any p-value <0.05 was considered significant.

**Results:**
Patient characteristics are shown in the Table-1. The mean ages of the study sample were 60.3±7.86 years for the group A (with anaemia) and 58.9±6.79 years for the group B (without anaemia) showing no a significant difference (p=0.2986; >0.05) in age distribution. In the study both sexes were homogenously distributed between the two groups but with clear male predominance (86% vs. 88%; p=0.766). The mean BMI were almost similar (26.98±2.3 vs. 27.2±2.14 kg/m$^2$, p = 0.5885; >0.05). The mean haemoglobin level among group A males was significantly lower than that among group B (11.7±1.18 vs. 13.6±0.55; p=<0.0001). The same was true for females (10.2±0.58 vs. 12.2±0.21; p=<0.0001). In our study, the commonest co-morbid factor was smoking in both groups (48% vs. 51%; p= 0.6716). It was followed by hypertension (43% vs. 47%; p=0.5697), diabetes mellitus (38% vs. 41%; p=0.6642) and dyslipidemia (34% vs. 35%; p=0.882). Other co-morbid factors were family history of CAD (10% vs. 8%), past history of CVA (4% vs. 3%), COPD (11% vs. 9%), history of MI (45% vs. 47%), PVD (9% vs. 8%) and renal dysfunction (10% vs. 14%). All were almost identically distributed between the groups (p > 0.05). In the study the mean left ventricular ejection fraction (LVEF) was almost similar in both groups (46 ± 5.7% vs. 47 ± 7.2; p = 0.2775). Pre-operative angiographic study demonstrated that majority of the patients had triple vessel diseases (TVD) in each group (76% and 72% respectively). The rest had double vessel diseases (DVD) and left main diseases (LMD) which were similarly distributed among the two groups (p>0.05). The distribution of NYHA and CCS angina classes between the two groups were also homogenous (p>0.05).

The mean operating times were similar in two groups (268.5 ± 33.5vs. 259.3 ± 34.8; p= 0.06). All the patients of both groups received left internal mammary artery (LIMA) and saphenous vein (SVG) as conduit. Radial artery was also used in some patients of both groups as second arterial conduit (24% vs. 28%; p=0.5190). It is important to mention that all the left anterior descending arteries (LAD) of both groups were anastomosed to LIMA. Intra-operatively 74% anaemic and 56% non-anaemic patients required blood transfusion (p=0.0076). Intra-operative hemoglobin level was significantly lower in group A than group B (9.1±1.1 vs. 10.7± 1.2; p=<0.000).

Post-operative transfusion of blood products was significantly higher among group A (56% vs. 28%; p=0.00006). The mean amount of transfused blood products was also higher in group A (1085 ± 45 vs. 690 ± 30; p=<0.0001). Although the 30 days mortality was similar among two groups, other post-operative variables like mechanical ventilation time, total bleeding, length of ICU stay, length of post-operative hospital stay were significantly higher among anaemic patients. Two patients of group A and one of group B required IABP post-operatively. Among the post-operative complications renal dysfunction was higher among anaemic patients (21% vs. 7%; p=0.0043). Other complications like low output syndrome (LOS) (6% vs. 2%; p=0.279), re-exploration for bleeding (3% vs.1%; p=0.6212), arrhythmia (10% vs. 8%; p=0.6212), peri-operative MI (2% vs. 25; p=1.000), stroke (3% vs.1%; p=0.6212), pulmonary complications (4% vs. 2%; p=0.6827), surgical site infection (6% vs. 4%; p=0.7475) were homogenously distributed among the two groups.

Table IV showed individual impact of ten risk factors on operative mortality and adverse cardiac outcomes. Among them intra-operative blood transfusion and intra-operative lowest haemoglobin <10 gram/dl showed significant relationship with adverse cardiac events e.g. death, low output syndrome, peri-operative MI, significant arrhythmia. None of them were significantly related to operative mortality.

**Table-I**

*Pre-Operative Characteristics of Patients with and without Anaemia (n=200)*

| Variables | Group A (n=100) | Group B (n=100) | *p* Value |
|---|---|---|---|
| Age, years# | 60.3±7.86* | 58.9±6.79* | 0.2986ns |
| Male, n (%)¥ | 86(86) | 88(88) | 0.766ns |
| BMI (kg/m²)# | 26.98±2.3* | 27.2±2.14* | 0.5885ns |
| Haemoglobin (gram/dl) | | | |
| Male | 11.7±1.18* | 13.6±0.55* | <0.0001s |
| Female | 10.2±0.58* | 12.2±0.21* | <0.0001s |
| Hypertension, n (%)¥ | 43(43) | 47(47) | 0.5697ns |
| Diabetes mellitus, n (%)¥ | 38(38) | 41(41) | 0.6642ns |
| Smoking, n (%)¥ | 48(48) | 51(51) | 0.6716ns |
| Dyslipidemia, n (%)¥ | 34(34) | 35(35) | 0.882ns |
| Family H/O CAD, n (%)¥ | 10(10) | 8(8) | 0.6212ns |
| Past H/O CVA, n (%)¶ | 4(4) | 3(3) | 1.000ns |
| COPD, n (%)¥ | 11(11) | 9(9) | 0.6373ns |
| History of MI, n (%)¥ | 45(45) | 47(47) | 0.7766ns |
| PVD, n (%)¥ | 9(9) | 8(8) | 0.7798ns |
| Renal dysfunction, n (%)¥ | 10(10.0) | 14(14) | 0.2841ns |
| Arrhythmia, n (%)¥ | 6(6) | 7(7) | 1.000ns |
| LVEF (%)# | 46 ± 5.7* | 47 ± 7.2* | 0.2775ns |
| NYHA class II or III, n (%)¥ | 16(16) | 14(14) | 0.6921ns |
| CCS angina class III or IV, n (%)¥ | 43(43) | 39(39) | 0.5652ns |
| LMD¥ | 10(10) | 12(12) | 0.6513ns |
| DVD¥ | 14(14) | 16(16) | 0.6921ns |
| TVD¥ | 76(76) | 72(72) | 0.519ns |

* Data are presented as the mean ± SD for continuous variable.
# Student's t-Test, ¥ Chi-square ($Ç^2$) Test, ¶ Fisher's Exact Test, s= significant, *ns* = Non-significant
CCS: Canadian Cardiovascular Society Angina Class; COPD: Chronic Obstructive Pulmonary Disease; CVA: Cerebrovascular Accident; DVD: Double Vessel Disease; LMD: Left Main Disease; MI: Myocardial Infarction; NYHA: New York Heart Association; PVD: Peripheral Vascular Disease; TVD: Triple Vessel Disease.

**Table-II**

*Operative Data of Patients with and without Pre-operative Anaemia (n=200)*

| Variables | Group A (n=100) | Group B (n=100) | *p* Value |
|---|---|---|---|
| Total operating time, minutes# | 268.5 ± 33.5* | 259.3 ± 34.8* | 0.06ns |
| Conduit used¥ | | | |
| LIMA, n (%) | 100(100) | 100(100) | 1.000ns |
| Radial artery, n (%) | 24(24) | 28(24) | 0.5190ns |
| SVG, n (%) | 100(100) | 100(100) | 1.000 ns |
| Graft distribution¥ | | | |
| LAD territory, n (%) | 100(100) | 100(100) | 1.000 ns |
| Circumflex territory, n (%) | 93(93) | 97(97) | 0.1944 ns |
| RCA territory, n (%) | 85(85) | 83(83) | 0.6997ns |
| Intra-operative transfusion of blood products, n (%)¥ | 74(74) | 56(56) | 0.0076s |
| Intra-operative lowest hemoglobin (gram/dl)# | 9.1±1.1 | 10.7± 1.2 | <0.0001s |

* Data are presented as the mean ± SD for continuous variable.
\# Student's t-Test, ¥ Chi-square ($Ç^2$) Test, s= significant, *ns* = Non-significant
LAD: Left Anterior Descending Artery; LIMA: Left Internal Mammary Artery; RCA: Right Coronary Artery; SVG: Saphenous Venous Graft.

**Table-III**

*Post-operative of Patients with and without Pre-operative Anaemia Data (n=200)*

| Variables | Group A (n=100) | Group B (n=100) | *p* Value |
|---|---|---|---|
| Post-operative transfusion of blood products¥ | 56(56) | 28(28) | 0.00006s |
| Amount of blood products needed (ml)# | 1085 ± 45* | 690 ± 30* | <0.0001s |
| 30 days mortality, n (%)¶ | 4(4) | 2(2) | 0.6827ns |
| Ventilation time, hours# | 11.4±2.3* | 8.6±3.5* | <0.0001s |
| LOS or Prolonged inotropic support¶ | 6(6) | 2(2) | 0.279ns |
| Postoperative IABP¶ | 2(2) | 1(1) | 1.000ns |
| Total bleeding (ml)# | 602 ± 85* | 378 ± 75* | <0.0001s |
| Length of ICU stay (days)# | 4.8± 2.5 | 3.4± 2.2 | <0.0001s |
| Length of post-operative hospital stay (days)# | 10.3 ± 1.3* | 8.2 ± 1.2* | <0.0001s |
| Re-exploration for bleeding¶ | 3(3) | 1(1) | 0.6212ns |
| Stroke¶ | 3(3) | 1(1) | 0.6212ns |
| Pulmonary complication¶ | 4(4) | 2(2) | 0.6827ns |
| Perioperative MI¶ | 2(2) | 2 (2) | 1.000ns |
| Arrhythmia¥ | 10(10) | 8(8) | 0.6212ns |
| Surgical site infection¶ | 6(6) | 4(4) | 0.7475ns |
| Renal dysfunction¥ | 21(21) | 7(7) | 0.0043s |

* Data are presented as the mean ± SD for continuous variable.
\# Student's t-Test, ¥ Chi-square ($Ç^2$) Test, ¶ Fisher's Exact Test, s= significant, *ns* = Non-significant
IABP: Intra-aortic Balloon Pump; ICU: Intensive Care Unit; LOS: Low Output Syndrome; MI: Myocardial Infarction.

**Table-IV**

*Independent Predictors of Operative Mortality and Adverse Cardiac Events*

| Variables of interest | Multivariate analysis of operative mortality | | | Multivariate analysis of adverse cardiac events | | |
|---|---|---|---|---|---|---|
| | Odds ratio (OR) | 95% CI for OR | *p* Value | Odds ratio (OR) | 95% CI for OR | *p* Value |
| Age | 1.56 | 0.14-17.47 | 0.7220$^{ns}$ | 2.06 | 0.72-5.9 | 0.1801$^{ns}$ |
| Obesity | 2.15 | 0.19-24.47 | 0.5360$^{ns}$ | 2.25 | 0.9-5.64 | 0.0851$^{ns}$ |
| Hypertension | 2.19 | 0.19-24.98 | 0.5291$^{ns}$ | 2.04 | 0.78-5.36 | 0.1488$^{ns}$ |
| Diabetes Mellitus | 1.67 | 0.26-10.59 | 0.5856$^{ns}$ | 1.78 | 0.69-4.59 | 0.2343$^{ns}$ |
| Dyslipidemia | 2.13 | 0.18-24.59 | 0.5463$^{ns}$ | 2.18 | 0.74-6.47 | 0.1594$^{ns}$ |
| Smoking | 2.17 | 0.19-24.78 | 0.5317$^{ns}$ | 1.87 | 0.66-5.31 | 0.2403$^{ns}$ |
| LVEF <40% | 1.94 | 0.17-22.44 | 0.5947$^{ns}$ | 2.32 | 0.76-7.09 | 0.1396$^{ns}$ |
| Pre-operative anaemia | 2.05 | 0.37-11.41 | 0.4162$^{ns}$ | 1.46 | 0.83-3.62 | 0.1437$^{ns}$ |
| Intra-operative blood transfusion | 2.32 | 0.24-22.96 | 0.4705$^{ns}$ | 3.15 | 1.01-9.81 | 0.0482$^{s}$ |
| Intra-operative lowest Hb* <10 gm/dl | 8.12 | 0.43-153.18 | 0.1621$^{ns}$ | 3.12 | 1.19-8.20 | 0.0212$^{s}$ |

s= significant, *ns* = Non-significant, Hb=Haemoglobin.

**Discussion:**

This study is unique in evaluating the effect of pre-operative anaemia on post-operative outcomes in patients undergoing exclusively isolated off-pump CABG. Previous studies have reported several advantages of off-pump CABG compared with conventional CABG, including less intra-operative haemodilution. During CABG with cardiopulmonary bypass, the crystalloid priming solution and cardioplegia solution may decrease the haemoglobin concentration, increase haemodilutional anaemia, and result in worse post-operative outcomes. The associated morbidities may occur more frequently in patients with pre-operative anaemia. Moreover, although the pre-operative anaemia may allow for a period of adaptation, haemodilutional anaemia causes a sudden change in tissue oxygenation. All these factors render patients with anaemia at higher risk of adverse events when they undergo CABG with cardiopulmonary bypass. In patients undergoing off-pump CABG, the effects of haemodilution with crystalloid priming solution and cardioplegic solution are eliminated.

According to the pre-operative characteristics the groups were comparable other than haemoglobin concentrations. Female patients had lower haemoglobin than male patients in each group. Studies by Kumar et al.[2] and Karkouti et al.[6] showed similar findings. However, Matsuda et al.[18] in their retrospective observational study showed that patients with pre-operative anaemia had more comorbidities than patients without pre-operative anaemia; patients with pre-operative anaemia were older and more likely to be female, and had a smaller body surface area, lower left ventricular ejection fraction, and greater renal dysfunction.

Although total operative time and graft distribution were similar among anaemic and non-anaemic groups, more patients of anaemic group required intra-operative blood transfusion (74% vs. 56%) as their mean haemoglobin level was lower. The ventilation time, length of ICU and post-operative hospital stay were significantly higher among anaemic patients. Kumar et al.[2] found that post-operative drainage, the need for blood and blood product transfusion, and length of ICU and hospital stay were statistically higher in low-haematocrit group. Matsuda et al.[18] found that in the post-operative period more patients with pre-operative anaemia required blood transfusion and the amount of blood loss and blood products transfused were also higher in those patients. It has been suggested that peri-operative RBC transfusion negatively affects outcomes after cardiac surgery. More recently, Zhang and colleagues[19] demonstrated that in patients who underwent CABG within 21 days of myocardial infarction, pre-operative anaemia was not associated with mortality or major adverse events; however, intraoperative RBC transfusion predicted major adverse events. In a study by Surgenor et al.[20] 36% of patients received one to two units of packed cell transfusion; among them, 43% were transfused intra-operatively and the rest were post-operatively transfused; the mortality rate was found to be 16% higher in patients receiving transfusion compared to those who did not receive it. Matsuda et al.[18] showed that patients with intra-operative RBC transfusion had worse outcomes than patients without intra-operative RBC transfusion. The primary purpose of RBC transfusion is to increase oxygen delivery, which is determined by cardiac output and arterial oxygen saturation, the latter being dependent on the haemoglobin level. However, the Transfusion Requirements after Cardiac Surgery trial conducted by Hajjar et al.[21] compared a restrictive transfusion strategy (<24%) with a liberal transfusion strategy (<30%), reported no difference in the primary end point (combined outcome of 30-day mortality and severe morbidity) between the groups. The restrictive transfusion strategy did not result in reduced oxygen availability to cells, as demonstrated by similar lactate levels in both groups. The adverse effects of RBC transfusion include acute haemolytic and non-haemolytic reactions; transmission of viral and bacterial diseases, transfusion-related acute lung injury, transfusion-related acute kidney injury, transfusion-related circulatory overload and immunosuppression. The decision to transfuse should be individualized and based on a rational approach that accounts for physiologic variables in addition to the haemoglobin level.

Among the post-operative complications, we found the incidence of renal dysfunction was higher among anaemic group. Although the actual incidences of operative mortality, stroke, peri-operative MI, arrhythmia, pulmonary complications and infective complications were higher among anaemic patients these were not statistically significant. Intra-operative blood transfusion and intra-operative lowest haemoglobin <10 gm/dl were found to be significantly related to adverse cardiac event but not operative mortality on multivariate analysis. A large study with greater sample size might show actual findings. Karkouti et al.[6] found that renal dysfunction was an important peri-operative pathophysiological factor for adverse outcome, being both a cause for and a result of pre-operative anaemia. It appears that the renal system especially with history of dysfunction was more sensitive than other organs to a temporary relative haemoglobin deficiency, thereby acting as a particularly sensitive and early indicator of pending ischemic injury to vital organs. Ranucci et al.[8] found that patients with pre-operative haematocrit levels <35% developed more than three-fold of major morbidities when compared to patients with pre-operative haematocrit levels of >42%. Circulation Karkouti et al.[6] showed that pre-operative anaemia was associated with an increase of all post-operative adverse events, starting at haemoglobin level <11 gm/dl in a dose-dependent fashion. Specially low pre-operative haemoglobin was an independent predictor for post-operative renal and central nervous system outcome and the association with increased cardiac adverse events was caused by concomitant risk factors prevalent in anaemic patients. The extent of comorbidities substantially amplified the adverse effects of low pre-operative haemoglobin, which in turn was a significant marker for severe underlying diseases and comorbidities. Matsuda et al.[18] in their study showed that patients with pre-operative anaemia had higher rates of low output syndrome, haemodialysis requirement, and the composite adverse outcome after isolated off-pump CABG than patients without pre-operative anaemia. Patients with pre-operative anaemia also tended to have a higher rate of operative death, but this difference was not statistically significant. However, multivariate analyses showed that old age was the independent predictor of mortality rather than pre-operative anaemia, other than old age high serum creatinine, prior myocardial infarction, and low ejection fraction were found to be significant independent predictors of mortality.

**Conclusion:**

The present study found that patients with preoperative anaemia had poorer outcomes after isolated off-pump CABG than patients without preoperative anaemia. Though the mortality among the anaemic patients was not significantly higher, a large scale study might have shown the exact scenario. The adverse outcomes might be related to associate comorbidities including age, smaller body surface area, lower glomerular filtration rate, congestive heart failure, non-elective surgery, and intraoperative blood transfusion. Cardiac surgery population is aging, and thus comorbid renal and central nervous system complications warrant increased attention because they play an important role in the decision to proceed with CABG. Awareness and optimization of risk factors prior to operation is essential for better outcomes and early recovery. We believe that preoperative haemoglobin level

**Study Limitations:**

The present study has several limitations and those are as follows:

1. Sample size was small and patients were selected purposefully. There was possible selection bias in patients selected for off-pump CABG rather than CABG with cardiopulmonary bypass.
2. They were not randomly assigned to either group.
3. Intra-operative and post-operative blood transfusion was at the discretion of the surgeon or anaesthesiologist. So the relative importance of pre-operative anaemia and intra-operative transfusion remained unclear.
4. The duration of follow up of this study was limited. Clinical outcomes were restricted to 30-days mortality. Patients were not followed up for medium and long-term results.
5. As a single institutional study the conclusions may not be applicable in general because of differences in practice patterns of other centres.

Other factors such as variations in surgical skill, patient difference in extent or distribution of coronary artery disease and echocardiography reports although unavoidable should also be considered.

**Recommendations:**

Despite the advances in cardiovascular medicine and cardiac surgical techniques, morbidity and mortality are still a problem after CABG. With increasing life expectancy, morbidity and mortality rates have also increased in elderly individuals. Due to this reason, preoperative assessment is extremely important to determine the risk factors. This study showed that anaemic patients undergoing OPCAB had an increased risk of postoperative adverse events. Importantly, the extent of pre-existing comorbidities substantially affected perioperative anaemia tolerance. By using risk stratification systems, operating surgeons, cardiac anaesthetists, ICU teams, patients' relatives, and the patients themselves become aware of what awaits them. We believe that preoperative haemoglobin level should be added to the risk scoring systems, which could be used to evaluate the patients' postoperative mortality risk and to predict the length of hospital stay and cost-efficacy.

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**References:**

1. Pala AA, Taner T, Tatli AB, Ozsin KK, Yavuz S. The Effect of Pre-operative Hematocrit Level on Early Outcomes After Bypass Surgery. Cureus. 2020;12(4):e7811. DOI 10.7759/ cureus. 7811.
2. Kumar S, Khurana NK, Awam I, Memon S, Memon MK, Sohail H, et al. The Effect of Preoperative Hematocrit Levels on Early Outcomes After Coronary Artery Bypass Graft. Cureus. 2021;13(1):e12733. DOI 10.7759/cureus.12733.
3. Egypt original : Sallam A, Hassan E. Effect of pre-operative hemoglobin level on early outcomes in patients undergoing urgent coronary artery bypass grafting. Journal of the Egyptian Society of Cardio-Thoracic Surgery. 2018;26: 252-256.
4. Bhavanadhar P, Srinivasan VR, Oruganti SS, Adiraju KP. A prospective study on prevalence and causes of anaemia in patients with acute coronary syndrome. Journal of Clinical and Diagnostic Research. 2016;10(7):01-05.
5. Benoist DB, McLean E, Egli I, Cogswell M, editors. Worldwide prevalence of anaemia 1993-2005: WHO global database on anemia, vol. 4. Swizerland: WHO; 2008 [Haemoglobin thresholds used to define anaemia].
6. Karkouti K, Wijeysundera DN, Beattie S. Risk Associated With Preoperative Anemia in Cardiac Surgery: A Multicenter Cohort Study. Circulation. 2008;117:478-484.
7. Williams ML, He X, Rakin JS, Slaughter MS, Gammie JS. (2013). Pre-Operative Hematocrit is a Powerful Predictor of Adverse Outcomes in Coronary Artery Bypass Graft Surgery: A Report from the Society of Thoracic Surgeons Adult Cardiac Surgery Database. The Annals of Thoracic Surgery.2013;96:1628-1634.
8. Ranucci M, Dedda DU, Castelvecchio S, Menicanti L, Frigiola A, Pelissero G. Surgical and Clinical Outcome Research Group (SCORE): Impact of Preoperative Anemia on Outcomes in Adult Cardiac Surgery: A Propensity-matched Analysis. Ann Thorac Surg. 2012;94:1134-42.
9. Bell ML, Grunwald GK, Baltz JH, McDonald GO, Bell MR, Grover FI, et al. Does pre-operative hemoglobin independently predict short-term outcomes after coronary artery bypass graft surgery? Ann of Thorac Surg. 2008;86:1415-1423.
10. Dai L, Mick SL, McCrae KR, Houghtaling PL, Sabik JF, Blackstone EH, et al. Pre-operative Anemia in Cardiac Operation: Does Hemoglobin Tell the Whole Story? Ann of Thorac Surg. 2018;105:100-107.
11. Miceli A, Romeo F, Glauber M, Siena PMD, Caputo M, Angelini. Preoperative Anemia Increases Mortality and Postoperative

Morbidity After Cardiac Surgery. Journal of Cardiaothoracic Surgery. 2014;9:137-143.

12. Magovern JA, Sakert T, Magovern GJ, Benckart DH, Burkholder JA, LieblerGA, et al. A Model that Predicts Morbidity and Mortality after Coronary Artery Graft Surgery. J Am Coll Cardiol. 1996;28:1147-53.
13. Nilsson JU, Ohlsson, M, Thulin L, Hogland P, Nashef SA, Brant J. Comparison Of 19 Preoperative Risk Stratification Models in Open Heart Surgery. Eur Heart J. 2006;27: 867-74.
14. Higgins TL, Estafanous FG, Loop FD, Beck GJ, Blum JM, Paranandi L. Stratification of Morbidity and Mortality Outcome by Preoperative Risk Factors In Coronary Artery Bypass Patients. A Clinical Severity Score. JAMA. 1992;267: 2344-2348.
15. Zindrou D, Taylor KM, Bagger JP. Preoperative Haemoglobin Concentration and Mortality Rate after CABG. Lancet 2002;359:1747-1748.
16. Egypt 8 Bojar R., In: Bojar R, editor. Manual of Peri-operative Care in Adult Cardiac Surgery. 5th ed. West Sussex:Wiley-Blackwell;2011.p.243-244.
17. Bojar R., In: Bojar R, editor. Manual of Peri-operative Care in Adult Cardiac Surgery. 5th ed. West Sussex:Wiley-Blackwell;2011.p.243-244.
18. Lamy A, Devereaux PJ, Prabhakaran D, Taggart DP, Hu S, Paolasso E. Off-Pump or On-Pump Coronary Artery Bypass Grafting at 30 Days. The New England Journal of Medicine. 2012;366:1489-1497.
19. Matsuda S, Fukui T, Shimizu J, Takao A, Takanashi S, Tomoike H. Associations Between Preoperative Anemia and Outcomes After Off-Pump Coronary Artery Bypass Grafting. Ann Thorac Surg. 2013;95:854-61.
20. Zhang L, Hiebert B, Zarychanski R, Arora RC. Preoperative Anaemia Does Not Increase the Risks of Early Surgical Revascularization After Myocardial Infarction. Ann Thorac Surg. 2013;95:542-7.
21. Surgenor SD, Kramer RS, Olmstead EM. The Association of Perioperative Red Cell Transfusions and Decreased Long-term Survival after Cardiac Surgery. Anesth Analg. 2009;108:1741-1746.
22. Hajjar LA, Vincent JL, Galas Fr. Transfusion requirements after cardiac surgery: the TRACS randomized control trial, JAMA. 2010;304:1559-67.

ORIGINAL ARTICLE

# Prediction of In-Hospital Major Adverse Cardiac Events (MACE) of Patients with Acute Coronary Syndrome using GRACE and TIMI Risk Scores in a tertiary hospital of Bangladesh

**Bishnu Pada Saha[1], Abdul Wadud Chowdhary[2], Mohsin Ahmed[3], Priyanka Adhikary[4], Mohammad Arifur Rahman[5], C M Kudrat E Khuda[6], Sudhakar Sarker[7]**

## Abstract

**Background:** Patient with acute coronary syndrome (ACS) has considerable variability in outcome and mortality risk. Global Registry of Acute Coronary Events (GRACE) & The Thrombolysis in Myocardial Infarction (TIMI) were a convenient bedside clinical risk scores for predicting in-hospital Major Adverse Cardiac Events (MACE) of patients with ACS at presentation. The aim of this study was to predict in-hospital Major Adverse Cardiac Events (MACE) in patients with ACS by using GRACE and TIMI risk scores.

**Methods:** This prospective observational study was carried out in the Department of Cardiology, Dhaka Medical College & Hospital (DMCH), Dhaka. After considering all ethical issues data were collected from 279 admitted patients with ACS by using questionnaire, clinical examination, ST changes in electrocardiogram, and relevant laboratory investigations. The GRACE & TIMI risk score was calculated for each patient. Patients were followed up till death or discharge and in-hospital MACE were noted. Tested predictive (sensitivity & specificity) accuracy of both GRACE & TIMI risk score to predict in-hospital MACE of the patients with ACS by receiver operative characteristics (ROC) curve.

**Results:** The study included 279 patients, 144 (51.6 %) had STEMI & 135 (48.6%) had UA/NSTEMI. In-hospital MACE were significantly ($p<0.001$) higher in patients with STEMI than patients with UA/NSTEMI (53.5% vs 29.6%). Sensitivity of both GRACE & TIMI risk score to predict in-hospital MACE of patients with STEMI as well as patients with UA/NSTEMI remained close to 100% with specificity >60% at the specified best cut off values ($p<0.05$). The best value for predicting of in-hospital MACE was a GRACE score of ≥165 and TIMI score of ≥6.0 in patients with STEMI whereas GRACE score of ≥123 and TIMI score of ≥3.0 in patients with UA/NSTEMI that is lower than established studies. Both GRACE & TIMI risk score had high c-statistics (≥0.70) but the different was <0.05.

**Conclusions:** Both the GRACE & TIMI risk score could predict in-hospital MACE of patients with ACS and may be readily applied as a In hospital bed side prognostic tool.

**Key words:** ACS, GRACE RISK SCORE, TIMI RISK SCORE

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## Introduction:

Cardiovascular diseases account for more than 17 million deaths (30% of all deaths) globally each year. Among them 80% occur in low and middle-income countries. This figure is expected to grow to 23.6 million by the year 2030 of which majority will be from South Asia. Coronary artery disease alone caused 7 million deaths worldwide in 2010 and it is an increase of 35% since 1990[1]. Estimates from the global burden of disease study suggest that by the year 2020 the South Asian part of the world will have more individuals with atherothrombotic cardiovascular disease than any other region[2]. The clinical presentations of coronary artery disease include silent ischemia, stable angina pectoris, non ST-elevation acute coronary syndrome (NSTE-ACS) comprising unstable angina and non ST elevation myocardial infarction, ST elevation myocardial infarction, heart failure and sudden death[3].

1. Dr. Bishnu Pada Saha, Junior Consultant, Department of Cardiology, National Institute of cardiovascular Diseases & Hospital, Dhaka, Bangladesh
2. Dr. Abdul Wadud Chowdhary, Professor & Head, Department of Cardiology, Dhaka Medical College, Dhaka, Bangladesh
3. Dr. Mohsin Ahmed, Associate Professor, Department of Cardiology, National Institute of cardiovascular Diseases & Hospital, Dhaka, Bangladesh
4. Dr. Priyanka Adhikary, Medical officer, Sir Salimullah Medical College & Hospital, Dhaka, Bangladesh
5. Dr. Mohammad Arifur Rahman, Junior Consultant, Department of Cardiology, Sorkari Karmachari Hospital , Dhaka, Bangladesh
6. Dr. C M Kudrat E Khuda, Assistant professor, Department of Cardiology, National Institute of cardiovascular Diseases & Hospital, Dhaka, Bangladesh
7. Dr. Sudhakar Sarker, Associate Consultant, Department of Cardiology, Bangladesh Specialized Hospital, Dhaka, Bangladesh

**Address of Correspondence:** Bishnu Pada Saha, Junior Consultant, National Institute of Cardiovascular Diseases & Hospital, Dhaka, Bangladesh, Mobile: 01913405685, Email address-dbps99@gmail.com.

The initial diagnosis of ACS is based on history, risk factors, and to a less extent, ECG findings[4]. Patients with ACS continue to have a poor outcome despite advances in modern therapies with a 30-day mortality rate ranging between 4.5% and 12.9% and a 6- month mortality rate ranging between 8.6% and 19.2%. A study conducted across Europe in 2000, reported in-hospital mortality of 6.0% among patients with acute myocardial infarction and 1.6% in unstable angina[5].Several prognostic scores have recently been proposed for risk stratification of the patient for in Hospital mortality. Some are derived from clinical trials such as TIMI (Thrombolysis in Myocardial Infarction)[6,7], PURSUIT (Platelet glycoprotein IIb–IIIa in Unstable angina, Receptor Suppression using Integrilin Therapy trial) and GUSTO (Global Utilization of Streptokinase and t-PA for Occluded coronary arteries) scores[8]. Others are derived from registries and cohort studies such as PREDICT (The Predicting Risk of Death In Cardiac Disease Tool) CCP (Cooperative Cardiovascular Project)[9] and GRACE (Global Registry of Acute Coronary Events)9 scores. Both TIMI and GRACE scores can be calculated from initial clinical history and electrocardiographic and laboratory data collected on admission. Both scores are sufficiently simple to be practical at the bedside for risk assessments across a wide spectrum of patients with ACS[11,12]. All of the patients were reviewed daily until hospital discharge to record Major Adverse Cardiac Events (MACE). Only the most serious events of major adverse cardiac events were used to calculate the cumulative major adverse cardiac events per patient according to the following sequence: death > asystole > cardiogenic shock > pulmonary edema (Acute LVF) > serious arrhythmia > recurrent angina. MACE is reported according to the standard definitions[12,13].

Outside the country, several studies have been found to in predicting to MACE of patients with ACS by using GRACE and TIMI risk scores. But in our country, no study has been done to compare these scores in predicting of the in-hospital MACE of patients with ACS. So, this study has been undertaken to predicting of the in-hospital MACE of patients with ACS by using the GRACE and TIMI risk scores.

## Materials & Methods:

Design and study population

Prospective observational study conducted at Department of Cardiology, Dhaka Medical College Hospital for 12 months. 279 patients selected from the study population were the sample population during the study period who fulfilled the inclusion and exclusion criteria.

Inclusion criteria: Patients with the diagnosis of ACS (STEMI, NSTEMI, UA) who were admitted in DMCH within the study period was selected in the study.

Exclusion criteria: Moderate to severe degree of valvular heart disease. Patient with congenital heart diseases Patients with non-coronary causes of chest pain. Patients with acute dyspnea from non- cardiac causes. Significant co-morbidity reducing life expectancy to <1 year. Patients unwilling to participate in this study.

Variables were studied: Evaluation of patients by taking history, clinical examination, ECG and Cardiac biomarkers, laboratory investigation and data was recorded in a pre-designed form (Data collection sheet). The variables were chosen as described TIMI and GRACE Risk Score system.

### Study procedure

- Patients admitted in the Department of Cardiology in DMCH, Dhaka, with ACS (STEMI, UA/NSTEMI) were considered for the study and those who fulfilled inclusion, exclusion criteria and agreed to enter the study protocol.
- Informed written consent was taken from each patient or legal guardian before enrollment.
- Meticulous history was taken and detailed clinical examination was performed and recorded in pre-designed structured form.
- Demographic data such as age, sex were recorded.
- Risk factor including diabetes mellitus, smoking, hypertension, dyslipidemia and family history of premature coronary artery disease were noted.
- Base line laboratory investigation includes ECG, TroponinI/CK-MB, RBS/FBS/HbA1c, serum creatinine, fasting lipid profile.
- After the initial assessment, ECG findings and cardiac biomarkers, the study subjects were divided into clinical subsets of patients with ST-Segment Elevation Myocardial Infarction (STEMI) and patients with Unstable Angina (UA)/non–ST Segment Elevation Myocardial Infarction (NSTEMI).
- Calculation of GRACE & TIMI risk scores was done for every study subject using the standardized GRACE & TIMI risk score models2,5,17,19.
- The enrolled patients were followed up every day upto death or hospital discharge and 12 lead ECG was done every morning and whenever needed at a paper speed of 25 mm/s and 10 mm standardization.
- In-hospital MACE of the enrolled patients were recorded in a pre-designed structured form.
- Tested predictive (sensitivity & specificity) accuracy of both GRACE & TIMI risk score to predict in-hospital MACE of the patients with ACS by receiver operative characteristics (ROC) curve.

**Statistical Analysis:**

Statistical analysis was performed using SPSS Statistical Software (version 22, SPSS Inc., Chicago, Illinois, USA). Continuous parameters were expressed as mean ±SD and categorical parameters as frequency and percentage. Comparisons between groups (continuous parameters) were done Unpaired Student's t-test. Categorical parameters were compared by Chi-Square test. The discrimination of GRACE & TIMI risk scores were tested using Receiver Operating Characteristics (ROC) curve (c- statistics). The significance of the results as determined in 95.0% confidence interval and a value of p <0.05 was consider to be statistically significant.

**Results:**

The total number of patients included in the study was 279 patients. The patients were divided into two groups: 144 patients (51.6%) STEMI &135 patients (48.6%) with UA/NSTEMI (Figure-1).

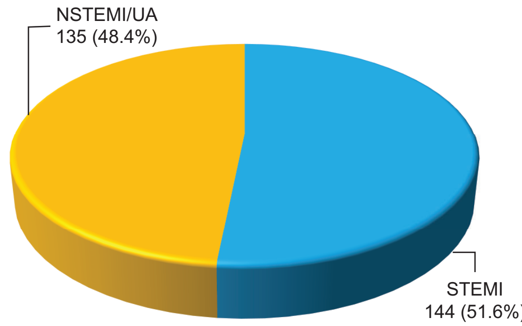
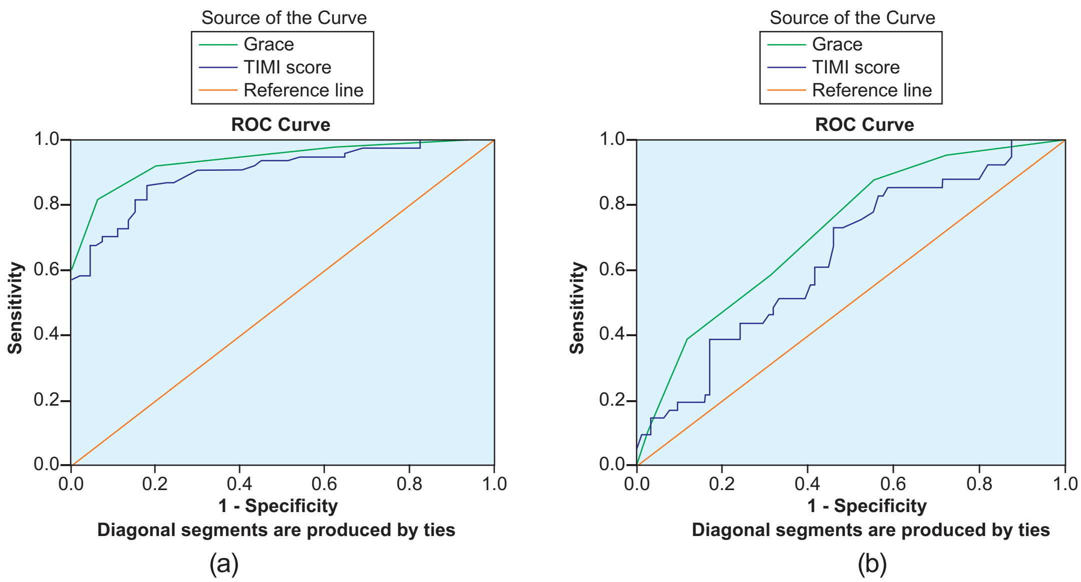



**Fig.-1:** *Pie diagram showing clinical Subsets of the study subjects.*

**Table-I**

*Differences between STIMI and UA/NSTEMI groups regarding socio-demographic variables and in hospital*

| Parameters | STEMI(n=144) | UA/NSTMI(n=135) | p value |
|---|---|---|---|
| Age group(in years) | | | |
| ≤40 | 17 (11.8%) | 23 (17.0%) | |
| 41-60 | 90 (62.5%) | 68 (50.4%) | |
| 61-80 | 33 (22.9%) | 40 (29.6%) | 0.768$^{ns}$ |
| > 80 | 4 (2.8%) | 4 (3.0%) | |
| Mean±SD | 54.4±12.4 | 54.9±15.1 | |
| Range | (30-85) | (25-100) | |
| Sex | | | |
| Male | 92 (63.9%) | 84 (62.2%) | |
| Female | 52 (36.10%) | 51 (37.8%) | 0.773$^{ns}$ |
| Total | 144(100.0%) | 135(100.0%) | |
| M:F ratio | 1.8:1 | 1.6:1 | |
| Risk factors | | | |
| Smoking | 67 (41.7%) | 58 (43.0%) | 0.549$^{ns}$ |
| Hypertension | 63 (43.8%) | 52 (38.5%) | 0.374$^{ns}$ |
| DM | 45 (31.3%) | 55 (40.7%) | 0.098$^{ns}$ |
| Dyslipidemia | 68 (47.2%) | 62 (46.0%) | 0.828$^{ns}$ |
| F/H of IHD | 13 (9.0%) | 5 (3.7%) | 0.070$^{ns}$ |
| ≥3 risk factors | 78 (54.2%) | 67 (49.5%) | 0.170 $^{ns}$ |
| Physical examination | | | |
| Pulse (b/min) | | | |
| < 100 | 34 (23.6%) | 87 (64.4%) | |
| ≥100 | 110 (76.4%) | 48 (35.6%) | 0.001$^{s}$ |
| Mean±SD | 106.4±27.5 | 94.5±32.2 | |
| SBP (mm of Hg) | | | |
| < 100 | 34 (23.6%) | 40 (29.6%) | |
| ≥100 | 110 (76.4%) | 95 (70.4%) | 0.233$^{ns}$ |
| Mean±SD | 111.9±18.3 | 108.9±24.5 | |
| Kilip class | | | |
| I | 81 (56.3%) | 104 (77.0%) | 0.001$^{s}$ |
| II-IV | 63 (43.7%) | 31 (23.0%) | |
| **In-hospital MACE** | | | |
| MACE | 77(53.5%) | 40 (29.6%) | |
| No MACE | 67 (46.5%) | 95 (70.4%) | <0.001$^{s}$ |




Null hypothesis: true area = 0.5

**Fig.-2***: Receiver operating characteristic (ROC) curves for GRACE & TIMI risk score to predict in-hospital MACE of the patients with STEMI(Figure-iia) & patients with NSTEMI/UA(Figure-iib)*

**Table-II**

*Receiver operating characteristic (ROC) curves for GRACE & TIMI risk score to predict in-hospital MACE of the patients with STEMI& patients with NSTEMI/UA.*

| Study subsets | STEMI (n=144) | | NSTEMI/UA(n=135) | |
|---|---|---|---|---|
| Risk Score | GRACE Risk Score | TIMI Risk Score | GRACE Risk Score | TIMI Risk Score |
| AUC | 0.902 | 0.902 | 0.699 | 0.712 |
| Cut off value | ≥165 | ≥6.0 | ≥123 | ≥3.0 |
| Sensitivity (%) | 85.7 | 82.2 | 82.9 | 87.8 |
| Specificity (%) | 61.1 | 62.6 | 63.6 | 65.7 |
| 95%CI : | 0.853–0.951 | 0.902–0.978 | 0.545–0.743 | 0.633–0.813 |
| p- value | <0.001$^{s}$ | <0.001$^{s}$ | <0.001$^{s}$ | <0.001$^{s}$ |

**Table-III**

*Association of in-hospital MACE and best cut off value of GRACE & TIMI risk score of patients with STEMI & patient with UA/ NSTEMI.*

| Risk Score | Cut off vale | In-Hospital MACE of STEMI | | | | p- value |
|---|---|---|---|---|---|---|
| | | Yes (n=77) | | No. (n=67) | | |
| | | N | % | N | % | |
| GRACE Risk Score | ≥165 | 62 | 80.5% | 13 | 19.4% | |
| | <165 | 15 | 19.5% | 54 | 80.6% | |
| TIMI Risk Score | ≥6.0 | 68 | 88.3% | 18 | 26.9% | |
| | <6.0 | 09 | 11.7% | 49 | 73.1% | |
| | | In-Hospital MACE of NSTEMI/UA | | | | |
| | | Yes (n=40) | | No (n=95) | | <0.001$^{s}$ |
| | | N | % | N | % | |
| GRACE Risk Score | ≥123 | 32 | 80.0% | 27 | 28.4% | |
| | <123 | 8 | 20.0%1 | 68 | 71.6% | |
| TIMI Risk Score | ≥3.0 | 34 | 85.0% | 31 | 32.6% | |
| | <3.0 | 6 | 15.0% | 64 | 67.4% | |

Most of the patients belonged in 41-60 years in the both STEMI & UA/NSTEMI group. A large number of patients in the both group belonged ≤40 year. The mean age was similar in both clinical subsets. Male was predominantly higher in both clinical subsets. (Table-I).

Sensitivity of both GRACE and TIMI risk score to predict in-hospital MACE of patients with STEMI as well as patients with UA/NSTEMI remained close to 100% with specificity >60% at the specified best cut off values. The best value for predicting of in-hospital MACE was a GRACE score of ≥165 and TIMI score of ≥6.0 in patients with STEMI whereas GRACE score of ≥123 and TIMI score of ≥3.0 in patients with UA/NSTEMI. (Figure-2, Table-II &Table-III).

**Discussion:**

The main objective of the study was to assess the utility of GRACE & TIMI risk scores to predict in-hospital Major Adverse Cardiac Events (MACE) of patients with acute coronary syndrome (ACS) in routine clinical practice. In present study, included 279 patients, 51.6% had patients with STEMI and 48.4% had patients with UA/NSTEMI that is dissimilar to other study[5,14,15].

In our study, large number of the patients belonged to 41-60 years age group in both patients with STEMI and patients with UA/NSTEMI (62.5 % & 50.34% respectively). The mean age was similar in both clinical subset (54.4±12.4 & 5 4.9±15.1 years respectively) that is similar to Abdelmoneium et al. (2014) study[14].

In present study, male patients were predominantly higher than female in the both clinical subset that is similar to almost all studies related to coronary artery disease[1,8-10,14-17]. Because female have less attention to their health particularly in low socioeconomic population like our country may contribute for this male predominance.In this study showed that smoking, hypertension, diabetes mellitus, dyslipidaemia, family history of IHD & three or more risk factors were no significant difference (p>0.05) between both clinical subset that is similar to Abdelmoneim et al. (2014)[14] and Montalescort et al. (2007)[17] study and also similar in other studies[15,16]. This insignificant difference between both clinical subsets may be little variation of their life style.

In this study, mean pulse (106.4±27.5 vs 94.5±32.2 b/min) was significantly higher in patients with STEMI group than patients with UA/NSTEMI group (p<0.05) because more complication occurs in patients with STEMI group that is similar to Abdelmoneim et al. (2014)[14] study. Patients without LVF (Killip class I) were significantly (p=0.001) higher in patients with UA/NSTEMI group (56.3% vs 77.0%) whereas patients with LVF (Killip class II-IV) were significantly higher (p=0.001) in patients with STEMI group (43.7% vs 23.0%) due to delayed arrival of large number of patients in hospital that is similar to the many published data[14,17-19]. In this study shown that, in-hospital Major Adverse Cardiac Events (53.5% vs 29.6%) were significantly higher in patients with STEMI (p<0.05) than patients with UA/NSTEMI that was dissimilar to the Abdelmonein study et al., 2014[14] (which state 23.3% in patients with STEMI group & 13.7% in patients with UA/NSTEMI group) because a large number of patients with ACS failed to reach the hospital timely.

In our study, sensitivity of both GRACE and TIMI risk score to predict in-hospital MACE of patients with STEMI as well as patients with UA/NSTEMI remained close to 100% with specificity >60% at the specified best cut off values. The best value for predicting of in-hospital MACE was a GRACE score of ≥165 and TIMI score of ≥6.0 in patients with STEMI whereas GRACE score of ≥123 and TIMI score of ≥3.0 in patients with UA/NSTEMI that is lower than established studies[6,7,14,18,20] 80.5 % in-hospital MACE was occurred in GRACE risk score ≥165 where as 19.5% in GRACE risk score <165 as well as 88.3 % in-hospital MACE was occurred in TIMI risk score ≥6.0 where as 11.7% in TIMI risk score <6.0 of patient with STEMI. That is statistically significant (p<0.05). Whereas 80.0 % in-hospital MACE was occurred in GRACE risk score ≥123 where as 20.0% in GRACE risk score <123 as well as 85.0% in-hospital MACE was occurred in TIMI risk score ≥3.0 where as 15.0% in TIMI risk score <3.0 of patient with UA/NSTEMI. That is also statistically significant (p<0.05).

In this study, both GRACE and TIMI risk score had high c-statistics (≥0.70) but the different was <0.05. As to consider a clinically relevant difference of c-statics at least 0.05 is necessary for superiority. So, we could say that, no one is superior of this study that was dissimilar to Abdelmoneim et al.,2014 study[13].

**Limitations:**

Although most of the result of this study have come up with the statistically significant findings, there are some facts to be considered which might affect the result. Details on management data could not be collected and hence analysis of the effect of management strategy on the outcome was not done. This is considered a limitation of this study. Although adequate number of study population was used in our study, we believe that it is still limited in number to generalize the results. It was conducted in a single center. Short follow up period

**Conclusion:**

In conclusion, our study demonstrated that for patients with ACS, both the GRACE and TIMI risk score could predict in-hospital MACE and may be readily applied as a prognostic tool at the bed side of hospital.

**Recommendations:**

From this study it may be recommended that GRACE and TIMI risk score can be used in patients with acute coronary syndrome (ACS) in the emergency department, coronary care unit or post coronary care unit at bed side to predict in-hospital MACE and provide information to the relatives of the patients about the planning of further management.

Nevertheless, further studies with large number of patients with multicenter approach are needed to assess this comparison of the GRACE and TIMI risk score in predicting of in-hospital MACE of patients with ACS.

**References:**


1. Wong, N. D., 2014, 'Epidemiological studies of CHD and the evolution of preventive cardiology'. Nature Reviews Cardiology, vol. 11, no. 5, pp. 276–289.
2. Chakraborty, B., Zaman, F. and Sharma, A. K., 2009, 'Combating Coronary Artery Disease in South Asia-What is Special'? Bangladesh Journal of Cardiology, vol. 01, no. 02, pp. 88–90.
3. Hamm, C. W., Bassand, J. P., Agewall, S., Bax, J., Boersma, E., Bueno, H., Caso, P., Dudek, D., Gielen, S., Huber, K., Ohman, M., Petrie, M. C., Sonntag,F., Uva, M. S., Storey, R. F., Wijns, W. and Zahger, D., 2011. ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST- segment elevation: The Task Force for the management of acute coronary syndromes (ACS) in patients presenting without persistent ST- segment elevation of the European Society ofCardiology (ESC). European Heart Journal,32(23), pp. 2999–3054.
4. Zellweger, MJ., Schaer, BA., Cron, TA., Pfisterer, ME., Osswald, 1S., 'Elevated troponin levels in absence of coronary artery disease after supraventricular tachycardia'. Swiss Med Wkly. vol.133, no. 31-32, pp.439-41.
5. Fox, KA., Cokkinos, DV., Deckers, J., Keil, U., Maggioni, A., Steg, G., 2000, 'The ENACT study: a pan-European survey of acute coronary syndromes. European Network for Acute Coronary Treatment'. Eur Heart J,vol. 21, no. 17, pp. 1440-9.
6. Antman, EM., Cohen, M., Bernink, PJ., McCabe, CH., Horacek, T., Papuchis, G., et al. 2000, 'The TIMI risk score for unstable angina/non-ST elevation MI: A method for prognostication and therapeutic decision making'. JAMA. J Am Med Assoc, vol. 284, no.7, pp. 835–42
7. Morrow, DA., Antman, EM., Charlesworth, A., Cairns, R., Murphy, SA., de Lemos, JA., et al. 2000, 'TIMI risk score for ST-elevation myocardial infarction: A convenient, bedside, clinical score for risk assessment at presentation: An intravenous nPA for treatment of infarcting myocardium early II trial substudy'. Circulation,vol. 102, no. 17, pp. 2031–7.
8. Califf, RM., Pieper, KS., Lee, KL., Van De Werf, F., Simes, RJ., Armstrong, PW., et al. 2000, 'Prediction of 1-year survival after thrombolysis for acute myocardial infarction in the global utilization of streptokinase and TPA for occluded coronary arteries trial' Circulation' vol. 101, no.19, pp.2231–8.
9. Krumholz, HM., Chen, J., Chen, YT., Wang, Y., Radford, MJ., 2001, 'Predicting one-year mortality among elderly survivors of hospitalization for an acute myocardial infarction: results from the cooperative cardiovascular project'. J Am CollCardiol, vol.38, no. 2, pp. 453–9.
10. Eagle, KA., Lim, MJ., Dabbous, OH., Pieper, KS., Goldberg, RJ., Van de Werf, F., et al. 2004, 'A validated prediction model for all forms of acute coronary syndrome: estimating the risk of 6-month postdischarge death in an international registry'. JAMA, vol. 291, no. 22, pp. 2727–33.
11. Bassand, JP., Hamm, CW., Ardissino, D., Boersma, E., Budaj, A., Fernandez- Aviles, F., et al.,2007, 'Task Force for D, Treatment of Non STSEACSoESoC, Guidelines for the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes'. Eur Heart J,vol. 28, no.13, pp. 1598–660.
12. Wright, RS., Anderson, JL., Adams, CD., Bridges, CR., Casey, Jr, DE., Ettinger, SM., et al., 2011, 'ACCF/AHA focused update incorporated into the ACC/AHA 2007 guidelines for the management of patients with unstable Angina/Non-ST-Elevation Myocardial Infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines developed in collaboration with the american academy of family physicians, society for cardiovascular angiography and interventions, and the of thoracic surgeons'. J Am Coll Cardiol, vol. 57, no.19, pp. e215-367. 53. Wu, AH., Abbas, SA., Green, S., Pearsall, L., Dhakam, S., Azar, R., et al. 1995,'Prognostic value of cardiac troponin T in unstable angina pectoris'. Am J Cardiol, vol. 76, no. 12, pp. 970-2.
13. Myocardial infarction redefined-a consensus document of The Joint European Society of Cardiology/ American College of Cardiology Committee for the redefinition of myocardial infarction,2007.
14. Abdelmoneium, HM., Ali, HH., Abdulkader, SS., 2014, 'Demographics of Acute Coronary Syndrome (ACS) Egyptian patients admitted to Assiut University Hospital:

Validation of TIMI and GRACE scores'. The Egyptian Journal of Critical Care Medicine, vol. 2, pp.3-11.

15. Donataccio, MP., Puymirat, E., Vassanelli, C., Blanchard, D., le Breton, H., Perier, MC., et al.,2014 ,'Presentation and revascularization patterns of patients admitted for acute coronary syndromes in France between 2004 and 2008 (from the National Observational Study of Diagnostic and Interventional Cardiac Catheterization'.Am J Cardiol, vol.113, no. 2, pp.243 8.

16. Fox, KA., Eagle, KA., Gore, JM., Steg, PG., Anderson, FA., Grace, investigators, G., 2010, 'The global registry of acute coronary events, 1999 to 2009– GRACE'. Heart, vol. 96, no. 14, pp.1095–101.

17. Montalescort G, Wiviott SD, Braunwald E 2009. Prasugrel compared with clopidogrel in patients undergoing percutaneous coronary intervention for ST-elevation myocardial infarction (TrITONTIMI-38) : double blind, randomized controlled trial. Lancet, vol. 373, pp 723-731.

18. Bradshaw, PJ., Ko, DT., 2006, 'Newman AM, Donovan LR, Tu JV. Validity of the GRACE (Global Registry of Acute Coronary Events) acute coronary syndrome predictionmodel for six-month post-discharge death in an independent data set'. Heart, vol. 92, pp. 905–9

19. Granger, CB., Goldberg, RJ., Dabbous,O., Pieper, KS., Eagle, KA., Cannon , CP., et al., 2003, 'Predictors of hospital mortality in the global registry of acute coronary events'.Arch Intern Med, vol.163, no. 19, pp.2345–53.

20. Newby DE, Grubb NR, Bradbury A.Cardiovascular disease. In: Colledge NR, Walker BR, Ralston SH, Penman ID eds. Davidson's Principles & Practice of Medicine. 22st ed. China: Churchill Livingstone, 2014: 542, 591.- See more at: http://nstemi.org/grace-score/#sthash.N8b0RGwL.dpuf.

ORIGINAL ARTICLE

# Immediate Hospital Outcome after Early Invasive Versus Delayed Ischaemia Driven Percutaneous Coronary Intervention in Non-ST Elevated Myocardial Infarction

**Rashedul Islam[1], Syed Ali Ahsan[2], MRM Mandal[3], Mohammad Hasimul Ahasan[4], AKM Fazlur Rahman[5], Md. Rasul Amin[6], Umme Salma Khan[7], Md. Mohasin Uddin[8], Sudipta Bakchi[9], Tanjima Parvin[10], Md Noornabi Khondaker[11]**

## Abstract:

**Background:** Optimal timing of PCI and comparative outcome between early invasive strategy and ischaemia guided delayed invasive strategy is still in debate in reducing short and long-term cardiovascular complications in NSTEMI. **Objective:** The aim of the study was to assess the impact of an early invasive strategy or ischaemia guided delayed invasive strategy on in hospital clinical outcomes in NSTEMI patients undergoing PCI, from a Bangladesh health service perspective. **Materials and Method:** It was an observational cross-sectional comparative study conducted in cardiology department of BSMMU from November 2019 to February 2021. **Study procedure:** This study enrolled 389 adult patients of NSTEMI who underwent PCI which met inclusion and exclusion criteria. Study subjects were divided into two groups: early and delayed groups. This study considered an early invasive strategy as - revascularization within 72h for patients presented with NSTEMI with high-risk features defined by a GRACE score > 140 and for those at lower risk with GRACE score <140; delayed ischaemia driven strategy as - revascularization after 72h, reserved for refractory, recurrent or severe exercise-induced ischaemia. Coronary angiogram (CAG) and PCI were performed by respective consultant according to current practice guidelines. After index PCI, patients were followed up during their hospitalized period for MACEs (Myocardial re-infarction, target vessel revascularization, stroke, hospitalization due to ischaemia causes and cardiac death) and findings of two groups were compared. **Results:** During hospital stay after index PCI, patients in the early group despite having worse initial presentation and higher GRACE score had better outcome in comparison with the delayed group who had a statistically significant higher incidence of cardiac death, MI, and target vessel revascularization ($p=0.002$, $p=0.004$ and $p=0.031$). However, incidence of stroke, major bleeding and hospitalization due to ischemia were not significantly different between the groups ($p>0.05$). **Conclusion:** Adoption of an early invasive strategy in NSTEMI patients undergoing PCI may be beneficial in reducing the risk of MACEs and associated with improved clinical outcome during in hospital follow-up.

**Keywords:** Non-ST elevated myocardial infarction (NSTEMI), Percutaneous coronary intervention (PCI), Major adverse cardiovascular events (MACEs).

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## Introduction:

Several randomized trials and meta-analyses have shown a benefit of an early invasive strategy followed by revascularization over a conservative or selective invasive approach with respect to death and myocardial infarction (MI) in non-ST-elevation acute coronary

1. Resident, Department of Cardiology, University Cardiac Center (UCC), Bangabandhu Sheikh Mujib Medical University, Dhaka (BSMMU), Dhaka, Bangladesh.
2. Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
3. Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
4. Resident, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
5. Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
6. Associate Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
7. Associate professpr and head of the Department of Cardiology, Uttora Adhunic Medical College and hospital, Dhaka, Bangladesh.
8. Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
9. Resident, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
10. Associate Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
11. Resident, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.

**Address of Correspondence:** Dr. Rashedul islam, Resident, Department of Cardiology, University Cardiac Center (UCC), Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. E-mail: rashed.sb36@gmail.com

syndromes (NSTE-ACS)[1-3]. Although numerous trials have investigated the outcome of an early versus a delayed invasive treatment strategy in patients with non-ST elevation acute coronary syndrome (NSTE-ACS), controversy remains about the optimal timing of angiography and revascularization in this patient group. Coronary artery disease (CAD) is an increasingly important medical and public health concern, and is the leading cause of mortality in Bangladesh. Like other South Asians, Bangladeshi people are unduly prone to develop CAD, which is often follows a rapidly progressive course and angiographically more severe[4]. Early intervention has the potential to prevent ischemic events during the waiting time from event to revascularization[5]. Conversely, a delayed intervention may avoid procedure- related complications by allowing plaque to stabilize during the waiting period, as the patient undergoes medical therapy[6,7]. The benefit of early revascularization reported by clinical trials is largely driven by lower incidence of refractory ischemia[8] or new MI,[5,9] rather than survival. Although a routine invasive policy is currently recommended by guidelines[10,11], the optimal timing of such intervention is not well established.

Current updated Guidelines on myocardial revascularization of Non-ST elevated myocardial infarction (NSTEMI) recommend, the use of an early invasive strategy within 12– 24 h for patients with high-risk features defined by a GRACE score >140 and invasive strategy or ischemia-guided strategy within 72 h for those at lower risk with GRACE score <140[12,13]. An ischemia-guided approach is recommended for patients with a low-risk score (TIMI 0 or 1, GRACE <140), other patients will benefit from an invasive strategy.

New angioplasty techniques, such as drug- eluting stents, most likely have a critical role in improving the results of PCI in NSTEMI patients. The use of stents has improved the short and long term outcomes of PCI in NSTEMI patients in terms of Major Adverse Cardiovascular Events (MACEs) include cardiac death, myocardial re- infarction, stroke, stent thrombosis, target vessel revascularization for ischemia.

With these uncertainties, we designed the study to determine the optimal timing of PCI in patients with non-ST-elevation MI (NSTEMI). Therefore, this study was designed to observe the difference in outcome between early invasive and delayed ischaemia driven successful PCI with drug-eluting stenting in NSTE-ACS patients in relation to major adverse cardiovascular events (MACEs) during hospital stay.

## Methods:

### Study design and Patients

This observational cross-sectional study was conducted at the Department of Cardiology, Bangabandhu Sheikh Mujib Medical University, Dhaka. The center has consistently been ranked as the one of the top hospitals in Bangladesh. Total duration was from November, 2019 to February, 2021. We studied 389 adult patients (age $\geq$18 years) of NSTEMI. Patients were excluded if they had chronic coronary syndrome, unstable angina congenital heart disease, significant valvular heart disease, cardiomyopathies, severe renal dysfunction, history of percutaneous coronary intervention and coronary artery bypass grafting. The protocol was approved by the local ethics committee and Institutional Review Board (IRB). Written informed consent was obtained from each patient after careful explanation.

### Study procedure:

Adult patients of NSTEMI who underwent invasive coronary angiography with percutaneous coronary intervention (PCI) were included in this study as per inclusion and exclusion criteria. Detailed history, physical examination and relevant laboratory tests including ECG and echocardiogram were done. Patients were divided into two groups: in one group-Patients undergoing early invasive strategy with PCI & in other group- Patients undergoing delayed ischaemia driven PCI. In this study we considered an early invasive strategy as - revascularization within 72h for patients presented with NSTEMI with high-risk features defined by a GRACE score > 140 and for those at lower risk with GRACE score <140; delayed ischaemia driven strategy as - revascularization after 72h, reserved for refractory, recurrent or severe exercise-induced ischaemia. Then patients underwent invasive evaluation by coronary angiography with PCI performed using drug Eluting Coronary Stent (DES) via either the trans-femoral or trans-radial approach by expert interventional cardiologist using standard protocols.

Procedural anticoagulation was achieved with unfractionated heparin; glycoprotein IIb/IIIa inhibitors were used whenever needed. Patients were receiving

180mg of Ticagrelor before the intervention. Thereafter, 75mg of aspirin daily and 90mg of Ticagrelor twice daily was prescribed. Other standard drugs (angiotensin converting enzyme inhibitors, beta blockers, statins and oral hypoglycemic agents) were unchanged during the study in order to minimize the effects of alterations on the variables.

Post PCI assessment by symptoms, H/O - occurrence of MACEs (hospitalization due to ischaemic causes, hospitalization due to myocardial re-infarction, hospitalization due to other cardiac causes, target vessel revascularization due to ischaemia, death due to cardiac causes, occurrence of Stroke, occurrence of major bleeding), detailed clinical examination and relevant laboratory investigation were done and recorded in predesigned structured proforma of data collection sheet. After that variables were compared between these two groups of patients: to find out any statistically significant difference.

**Statistical analysis:**

After collection of all information, these data were checked, verified for consistency and edited for finalized result. Continuous variables are expressed as mean value±standard deviation or as median. Categorical variables are expressed as absolute number and percentages which were presented as frequency tables and charts. Continuous data were analyzed and compared by Student's t-test and categorical data by Chi-square test. Binary logistic regression analysis was used to determine independent predictors of MACEs Differences were considered significant when P value less than 0.05. Statistical analyses were carried out by SPSS version 25.0 windows software.

**Results:**

Of the 391 patients in the study, 227 patients were in 'early' group and 162 patients were in 'delayed' group. Owing to withdrawal of consent, 2 patients were excluded, leading to 389 patients for the final analysis. Baseline characteristics were well balanced between treatment groups (Table 1). Then findings were compared between two study groups.

The mean age of the participants of early and delayed group were 52.61±10.91and 52.26±8.92 years respectively. A male predominance (65.8% vs. 88.9%) was observed in either group. Majority of the patients in both groups were overweight and obese, and less than one fourth of study subjects had normal (18.0-22.9 kg/m2) BMI (BMI>23 is considered overweight in Asian). Most of the patients had multiple risk factors. Hypertension was the most prevalent risk factor in both groups 60.5%. Distribution of risk factors among the study subjects were Hypertension (60.5% vs 55.6%), DM (52.6% vs 44.4%), smoking (36.8% vs 51.9%), dyslipidemia (52.2% vs 44.9%), CKD (1.7% vs 7.8%) and family history of CAD (52.4% vs 43.9%) in early and delayed group respectively (Table 1).

Double vessel disease (DVD) was more common in delayed group (51.9%) than early group (50.0%) but the difference was statistically not significant (p=0.751). Single vessel disease (SVD) more common in delayed group (48.1%) and triple vessel disease (TVD) were more common in early group (13.2%). PCI to RCA, LAD and LCX were more common in early group (Table 2).

During analysis, clinical outcomes were found better in early group than in delayed group in terms of symptoms (chest pain-10.5% vs 17.3%, SOB-6.1% vs 6.2%) and good functional capacity (90.3% vs 86.4%), poor functional capacity (9.7% vs 13.6%) (Table 3).

The patients of the early group experienced a lower incidence of MI, target vessel revascularization (TVR) and cadiac death during follow up after post PCI period. The incidence of MI, cardiac death, target vessel revascularization soon after PCI was found statistically significant between early group than delayed group (p=0.004, p=0.002, p=0.031 respectively). No other adverse events were found significantly different between the two groups. Incidence of target vessel revascularization, cardiac death, stroke, major bleeding and hospitalization due to ischemia were higher in delayed group than early group (8.4% vs 3.5%, 10.5% vs 3.1%, 2.5% vs 0.9%, 1.2% vs 0.9%, and 4.9% vs 2.6%) and stroke, major bleeding and hospitalization due to ischemia (have p value of 0.210, 0.733 and 0.230 respectively) which were not statistically significant (Table 4). Binary logistic regression analysis for predictors of MACEs were presented in Table 5. After adjustment for potential confounders the risk of MACEs in delayed group of patients were 2.14 times (OR= 2.14; 95% CI, 1.17 - 3.68; p = Â0.001). The confounders included age, sex, BMI, hypertension, dyslipidemia, smoking, renal insufficiency, family history of CAD, DVD and TVD. The findings of the study data analyses are documented in Tables.

**Table-I**

*Associations of the various demographic, clinical, biochemical and echocardiographic variables between early and delayed groups of study patients (N=389)*

| Variables | Early Group (n=227) mean±SD or No. (%) | Delayed Group (n=162) mean±SD or No. (%) | P Value |
|---|---|---|---|
| Age (year) | 52.61±10.91 | 52.26±8.92 | 0.688$^{ns}$ |
| Sex | | | |
| Male | 150(65.8) | 144(88.9) | Â0.001$^{s}$ |
| Female | 78(34.2) | 18(11.1) | |
| BMI (kg/m$^2$) | 24.51±2.39 | 24.17±2.22 | 0.175$^{ns}$ |
| Risk factors | | | |
| Diabetes Mellitus | 120(52.6) | 72(44.4) | 0.101$^{ns}$ |
| Hypertension | 137(60.5) | 90(55.6) | 0.344$^{ns}$ |
| Smoking Status | 126(55.7) | 84(51.9) | 0.475$^{ns}$ |
| Dyslipidemia | 120(52.6) | 79(48.7) | 0.425$^{ns}$ |
| CKD | 4(1.8) | 5(3.0) | 0.397$^{ns}$ |
| F/H of CAD | 120(52.6) | 72(44.4) | 0.090$^{ns}$ |
| Clinical presentation | | | |
| Chest Pain | 223(98.2) | 160(98.8) | 0.771$^{ns}$ |
| SOB | 14(6.1) | 4(2.2) | 0.214$^{ns}$ |
| SBP (mmHg) | 120.9±12.24 | 124.8±13.69 | 0.043$^{s}$ |
| Heart rate (bpm) | 87.14±6.58 | 81.5±7.19 | 0.001$^{s}$ |
| Biochemical tests | | | |
| HbA1c (%)Lipid profiles (mg/dl) | 8.9±1.0 | 7.1±1.3 | 0.029$^{s}$ |
| Total cholesterol | 195.9±73.9 | 190.6±66.9 | 0.806$^{ns}$ |
| Triglyceride | 210.0±61.0 | 195.5±62.3 | 0.470$^{ns}$ |
| HDL-C | 44.5±12.3 | 46.9±9.8 | 0.460$^{ns}$ |
| LDL-C | 120.3±36.8 | 124.6±31.8 | 0.677$^{ns}$ |
| S.Creatinine (mg/dl) | 1.1±0.18 | 1.07±0.13 | 0.678$^{ns}$ |
| Ischaemic ECG changes | | | |
| ST-segment depression | 147(64.9) | 30(18.5) | <0.001$^{s}$ |
| T-wave inversion | 162(71.1) | 18(11.1) | <0.001$^{s}$ |
| Echocardiography | | | |
| LVEF (%) | 51.5±9.1 | 52.5±9.8 | 0.750$^{ns}$ |
| GRACE Score | 143.14±19.4 | 127.3±14.7 | <0.001$^{s}$ |

BMI=Body Mass Index, CAD=Coronary Artery Disease, CKD=Chronic Kidney Disease, GRACE=Global Registry of Acute Coronary Events, HDL-C=High Density Lipoprotein-Cholesterol, LDL-C=Low Density Lipoprotein-Cholesterol, LVEF=Left Ventricular Ejection Fraction, SBP=Systolic Blood Pressure, SOB= shortness of breath, s=significant, ns=not significant.

The use of medication, including Dual antiplatelet therapy (DAPT) in the form of aspirin and thienopyridines (ticagrelor), angiotensin-converting enzyme-inhibitors, and statins, was high and similar in the two treatment groups.

**Table-II**

*Angiographic characteristics of the study patients (N=389)*

| Vaiables | Early Group (n=227) No. (%) | Delayed Group (n=162) No. (%) | p-value |
|---|---|---|---|
| Extent of coronary disease | | | |
| SVD | 84(36.8) | 78(48.1) | $0.027^{s}$ |
| DVD | 114(50.0) | 84(51.9) | $0.751^{ns}$ |
| TVD | 30(13.2) | 0(0) | Â$0.001^{s}$ |
| Culprit lesion | | | |
| LM | 6(2.6) | 12(7.4) | $0.027^{s}$ |
| LAD | 108(47.4) | 66(40.7) | $0.181^{ns}$ |
| LCX | 108(47.4) | 36(22.2) | $<0.001^{s}$ |
| RCA | 120(52.6) | 60(37.0) | $0.002^{s}$ |

SVD=Single vessel disease, DVD=Double vessel disease, TVD=Triple vessel disease, LAD=Left Anterior Descending, LCX=Left Circumflex, RCA=Right Coronary Artery, s=significant, ns=not significant.

**Table-III**

*In hospital clinical outcomes between two groups (N=389)*

| Vaiables | Early Group (n=227) No. (%) | Delayed Group (n=162) No. (%) | p-value |
|---|---|---|---|
| Chest pain | 24(10.5) | 28(17.3) | $0.171^{ns}$ |
| Symptoms | | | |
| SOB | 14(6.1) | 10(6.2) | $0.993^{ns}$ |
| Good | 206(90.3) | 140(86.4) | |
| Functional Capacity | | | $0.393^{ns}$ |
| Poor | 22(9.7) | 22(13.6) | |

SOB= shortness of breath, s=significant, ns=not significant.

**Table-IV**

*In hospital clinical outcomes between two groups (N=389)*

| Major adverse cardiovascular Events (MACEs) | Early Group (n=227)No. (%) | Delayed Group (n=162)No. (%) | p-value |
|---|---|---|---|
| MI 6(2.6) | 15(9.2) | $0.004^{s}$ | |
| Target Vessel revascularization | 8(3.5) | 14(8.4) | $0.031^{s}$ |
| Cardiac Death | 7(3.1) | 17(10.5) | $0.002^{s}$ |
| Stroke | 2(0.9) | 4(2.5) | $0.210^{ns}$ |
| Major Bleeding | 2(0.9) | 2(1.2) | $0.733^{ns}$ |
| Hospitalization due to Ischaemia cause | 6(2.6) | 8(4.9) | $0.230^{ns}$ |

s=significant, ns=not significant.

**Table-V**

*Binary logistic regression analysis for predictors of major adverse effects within hospitalized period (N=389)*

| Variables | Univariate analysis | | | Multivariate analysis | | |
|---|---|---|---|---|---|---|
| | OR | 95%CI | p-value | OR | 95%CI | p-value |
| Age | | | 0.583$^{ns}$ | 1.01 | 0.97 - 1.04 | 0.623$^{ns}$ |
| Gender (Male) | 1.04 | 0.43-2.51 | 0.915 $^{ns}$ | 1.10 | 0.39 - 3.12 | 0.851$^{ns}$ |
| BMI | | | 0.947 $^{ns}$ | 1.02 | 0.85 - 1.22 | 0.822$^{ns}$ |
| Hypertension | 1.08 | 0.53-2.29 | 0.819 $^{ns}$ | 1.16 | 0.52 - 2.57 | 0.707$^{ns}$ |
| Dyslipidaemia | 0.49 | 0.23-1.06 | 0.069 ns | 2.16 | 0.96 - 4.88 | 0.063$^{ns}$ |
| Smoking | 0.95 | 0.47-1.90 | 0.895 $^{ns}$ | 1.13 | 0.49 - 2.61 | 0.762$^{ns}$ |
| CKD | 0.92 | 0.36-2.33 | 0.873 $^{ns}$ | 1.24 | 0.45 - 3.39 | 0.671$^{ns}$ |
| F/H of CAD | 1.26 | 0.59-2.68 | 0.540 ns | 0.95 | 0.42 - 2.16 | 0.910$^{ns}$ |
| Delayed group | 1.85 | 2.68-4.08 | <0.001$^{s}$ | 2.14 | 1.17 - 3.68 | Â0.001$^{s}$ |
| DVD | 1.03 | 0.51- 2.07 | 0.918 $^{ns}$ | 1.10 | 0.47 - 2.58 | 0.821$^{ns}$ |
| TVD | 1.35 | 0.58-3.13 | 0.001$^{s}$ | 1.06 | 0.37 - 2.99 | 0.914$^{ns}$ |

ns=not significant, s=significant, BMI=Body Mass Index, CAD=Coronary Artery Disease, CKD=Chronic Kidney Disease, DVD=Double vessel disease, TVD=Triple vessel disease.

## Discussion

In this single-center observational cross- sectional study, we investigated the outcome comparision between early and delayed invasive strategy in NSTEMI patients undergoing PCI with DES. In this analysis, NSTEMI patients undergoing early percutaneous intervention was associated with better clinical outcome.

The patients of the early group experienced a lower incidence of MI, TVR and cadiac death at follow up during post PCI period hospitalization. Distribution of MACEs like stroke, major bleeding and hospitalization due to ischaemic causes were 0.9%, 0.9% and 2.6% in patients of early group and 2.5%, 1.2% and 4.9% in delayed group respectively, but which were not statistically significant. Following the drug eluting stent placement, the incidence of MI in the early group was 2.6% as opposed to 9.2% in the delayed group which was statistically significant (p=0.004). Swahn et al. 2012, demonstrated prevalence of MI during follow up at post PCI was 7.8% in early group and 6.6% in delayed group respectively, HR 1.08(0.36-3.25)[14]. Thiele H. et al. 2017, showed demonstrated incidence of MI during follow up at post PCI was 20% in early group and 16% in delayed group respectively, (p=0.070).[15] The TACTICS TIMI-18 trial showed occurrence of death, nonfatal MI or rehospitalization for NSTE-ACS at six months was 19.4% with the conservative approach and 15.9% with the early invasive strategy (p = 0.025), with significant reductions in death or MI from 9.5% to 7.3% (p= 0.0498)[16].

The better prognosis with early vs. late PCI among NSTEMI patients in this study consistent with a few prior studies and it is worthwhile to compare the results of this study with those of landmark clinical trials: the TIMI- IIIB (the Thrombolysis In Myocardial Infarction) trials[17], the VANQWISH (the Veterans Affairs Non–Q-Wave Infarction Strategies in Hospital) trials,[18] the FRISC II (the Fragmin and fast Revascularization during InStability in Coronary artery disease) trials,[19] and the TACTICS TIMI-18 (the Treat Angina with Aggrastat and determine Cost of Therapy with an Invasive or Conservative Strategy) trials[16]. The TIMI-IIIB and the VANQWISH trials have been the primary basis for use of “ischemia-guided” therapy while the FRISC II and the TACTICS have, identified advantages of an “early invasive” approach. The TIMI-IIIB authors concluded that similar early and late outcomes were achieved with the two approaches with respect to death and MI. Given the similar outcomes with the two different strategies, patients could be managed individually depending upon the severity of their presentation, cardiac risk factors, left ventricular function, and response to medical therapy. The VANQWISH trial concluded that the early conservative approach was the preferred treatment strategy for patients with NSTEMI. Different enrollment criteria and baseline characteristics of the subjects may explain the discrepant results between this study and these major trials, this study included only patients undergoing PCI, whereas the majority of patients in those trials did not.

It was observed that, despite receiving standard treatment as well as advice for life style modification, dietary advice during discharge from hospital, incidence of MACEs were significantly higher at follow up in delayed group of patients in comparison to early group of patients.

### Limitations

The sample was taken from a single center. Result of the study might be influenced by relatively smaller sample size. So, findings may not represent the impact of both the early invasive and delayed invasive strategy in all the Bangladeshi NSTEMI cohort undergoing PCI. The study sample was taken consecutively (non-randomly), sampling method was purposive, so there was risk of selection bias- which might have affected the outcome of the study. Longer-term follow up will add further insight into the problem.

### Conclusion:

In conclusion, these data suggest that early invasive strategy in NSTEMI patients undergoing percutaneous coronary intervention (PCI) may be beneficial in reducing the risk of MACEs and improvement of the clinical outcome after PCI.

### Conflict of interest:

Authors declare no conflicts of interest.

### References:

1. Bavry AA, Kumbhani DJ, Rassi AN, Bhatt DL, Askari AT. Benefit of early invasive therapy in acute coronary syndromes: a meta-analysis of contemporary randomized clinical trials. J Am Coll Cardiol 2006;48:1319–1325.
2. Mehta RH, Cannon CP, Fox KA, Wallentin L, Boden WE, Spacek R, Widimsky P, McCullough PA, Hunt D, Braunwald E, Yusuf S. Routine vs selective invasive strategies in patients with acute coronary syndromes. A collaborative meta-analysis of randomized trials. JAMA 2005;293:2908–2917.
3. Fox KAA, Clayton TC, Damman P, Pocock SJ, de Winter RJ, Tijssen JGP, Lagerqvist B, Wallentin L. Long-term outcome of a routine versus selective invasive strategy in patients with non-ST- segment elevation acute coronary syndrome: a meta-analysis of individual patient data. J Am Coll Cardiol 2010;55:2435–2445.
4. 4 Islam AM, Majumder AA. Coronary artery disease in Bangladesh: A review. Indian heart journal. 2013 Jul 1;65(4):424- 35.
5. 5 Neumann FJ, Kastrati A, Pogatsa-Murray G, Mehilli J, Bollwein H, Bestehorn HP, Schmitt C, Seyfarth M, Dirschinger J, Schomig A. Evaluation of prolonged antithrombotic pretreatment (“cooling-off” strategy) before intervention in patients with unstable coronary syndromes: A randomized controlled trial. JAMA 2003;290:1593–1599.
6. 6 de Winter RJ, Windhausen F, Cornel JH, Dunselman PH, Janus CL, Bendermacher PE, Michels HR, Sanders GT, Tijssen JG, Verheugt FW. Invasive versus Conservative Treatment in Unstable Coronary Syndromes (ICTUS) Investigators. Early invasive versus selectively invasive management for acute coronary syndromes. N Engl J Med 2005;353:1095–1104.
7. 7 Riezebos RK, Ronner E, Ter Bals E, Slagboom T, Smits PC, ten Berg JM, Kiemeneij F, Amoroso G, Patterson MS, Suttorp MJ, Tijssen JG, Laarman GJ. OPTIMA trial. Immediate versus deferred coronary
   a. angioplasty in non-ST-segment elevation acute coronary syndromes. Heart 2009;95:807–812.
8. 8Mehta SR, Granger CB, Boden WE, Steg PG, Bassand JP, Faxon DP, Afzal R, Chrolavicius S, Jolly SS, Widimsky P, Avezum A, Rupprecht HJ, Zhu J, Col J, Natarajan MK, Horsman C, Fox KA, Yusuf S; TIMACS Investigators. Early versus delayed invasive intervention in acute coronary syndromes. N Engl J Med 2009;360:2165–2175.
9. 9 Milosevic A, Vasiljevic-Pokrajcic Z, Milasinovic D, Marinkovic J, Vukcevic V, Stefanovic B, Asanin M, Dikic M, Stankovic S, Stankovic G. Immediate Versus Delayed Invasive Intervention for Non-STEMI Patients: The RIDDLE-NSTEMI Study. JACC Cardiovasc Interv 2016;9:541–549.
10. 10. Anderson JL, Adams CD, Antman EM, Bridges CR, Califf RM, Casey DE, Chavey WE, Fesmire FM, Hochman JS, Levin TN, Lincoff AM, Peterson ED, Theroux P, Wenger NK, Wright RS. ACC/AHA 2007 guidelines for the management of patients with unstable angina/non-ST-elevation myocardial infarction. Circulation 2007;116:e148–e304.
11. 11. Bassand JP, Hamm CW, Ardissino D, Boersma E, Budaj A, Fernandez-Aviles F, Fox KA, Hasdai D, Ohman EM,Wallentin L, WijnsW. Guidelines for the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes. Eur Heart J 2007;28:1598–1660.
12. 12 Kushner FG, Hand M, Smith SC Jr, King SB III, Anderson JL, Antman EM, Bailey SR, Bates ER, Blankenship JC, Casey DE Jr, Green LA, Hochman JS, Jacobs AK, Krumholz HM, Morrison DA, Ornato JP, Pearle DL, Peterson ED, Sloan MA, Whitlow PL, Williams DO. 2009 Focused Updates: ACC/AHA Guidelines for the Management of Patients with ST-Elevation Myocardial Infarction (Updating the 2004 Guideline and 2007 Focused Update) and ACC/AHA/SCAI Guidelines on Percutaneous Coronary Intervention (Updating the 2005 Guideline and 2007 Focused Update): A Report of the American College of Cardiology Foundation/ American Heart Association
   a. Task Force on Practice Guidelines. Circulation 2009; 120:2271–2306.
13. 13. Wijns W, Kolh P, Danchin N, Di Mario C, Falk V, Folliguet T, Garg S, Huber K, James S, Knuuti J, Lopez-Sendon J, Marco J, Menicanti L, Ostojic M, Piepoli MF, Pirlet C, Pomar JL, Reifart N, Ribichini FL, Schalij MJ, Sergeant P, Serruys PW, Silber S, Sousa Uva M, Taggart D, Vahanian A, Auricchio

A, Bax J, Ceconi C, Dean V, Filippatos G, Funck-Brentano C, Hobbs R, Kearney P, McDonagh T, Popescu BA, Reiner Z, Sechtem U, Sirnes PA, Tendera M, Vardas PE, Widimsky P, Alfieri O, Dunning J, Elia S, Kappetein P, Lockowandt U, Sarris G, Vouhe P, von Segesser L, Agewall S, Aladashvili A, Alexopoulos D, Antunes MJ, Atalar E, Brutel de la Riviere A, Doganov A, Eha J, Fajadet J, Ferreira R, Garot J, Halcox J, Hasin Y, Janssens S, Kervinen K, Laufer G, Legrand V, Nashef SA, Neumann FJ, Niemela K, Nihoyannopoulos P, Noc M, Piek JJ, Pirk J, Rozenman Y, Sabate M, Starc R, Thielmann M, Wheatley DJ, Windecker S, Zembala M. Guidelines on myocardial revascularization: The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio- Thoracic Surgery (EACTS). Eur Heart J 2010; 31:2501–2555.

14. 14 Swahn E, Alfredsson J, Afzal R, Budaj A, Chrolavicius S, Fox K, Jolly S, Mehta SR, de Winter R, Yusuf S. Early invasive compared with a selective invasive strategy in women with non-ST-elevation acute coronary syndromes: a substudy of the OASIS 5 trial and a meta-analysis of previous randomized trials. European heart journal. 2012 Jan 1;33(1):51-60.

15. 15 Thiele H, Rach J, Klein N, Pfeiffer D, Hartmann A, Hambrecht R, Sick P, Eitel I, Desch S, Schuler G. Optimal timing of invasive angiography in stable non-ST- elevation myocardial infarction: the Leipzig Immediate versus early and late PercutaneouS coronary Intervention triAl in NSTEMI (LIPSIA-NSTEMI Trial). European heart journal. 2012 Aug 1;33(16):2035-43.

16. 16 Cannon CP, Weintraub WS, Demopoulas LA, et al. Comparison of early invasive and conservative strategies in patients with unstable angina and non– ST-segment elevation myocardial infarction treated with the glycoprotein IIb/IIIa inhibitor tirofiban. N Engl J Med 2001;344:1879–87

17. 17 The TIMI IIIB Investigators. Effects of tissue plasminogen activator and a comparison of early invasive and conservative strategies in unstable angina and non–Q-wave myocardial infarction: results of the TIMI IIIB trial. Circulation 1994;89:1545–56.

18. 18 Boden WE, O'Rourke RA, Crawford MH, et al. Outcomes in patients with acute non–Q-wave myocardial infarction randomly assigned to an invasive as compared with a conservative management strategy. N Engl J Med 1998;338:1785–92.

19. 19 Fragmin and Fast Revascularisation During Instability in Coronary Artery Disease Investigators. Invasive compared with non-invasive treatment in unstable coronary artery disease: FRISC II prospective randomised multicentre study. Lancet 1999;354:708–15.

ORIGINAL ARTICLE

# Significance of Reciprocal Changes on Angiographic Severity of Patients with Acute Inferior STEMI

**Amit Mishra[1], Tanjima Parvin[2] , MRM Mandal[3],Syed Ali Ahsan[4], Manzoor Mahmood[5], Rajan Karna[6], Umme Salma Khan[7].**


## Abstract:

**Background:** The significance of the reciprocal changes in the early stage of acute inferior wall myocardial infarction whether it is truly reciprocal or represents ischemia at a distance revealed by echocardiography and coronary angiogram is still debatable.

**Objective:** The aim of the study was to compare Severity of CAD by CAG among patients having reciprocal changes in ECG with STEMI Inferior and without reciprocal changes, from a Bangladesh population.

**Materials and Method:** This was a Cross Sectional observational study which was conducted in UCC, BSMMU during the period of one year (10th March 2020 to 31st December 2020). This study enrolled 48 adult patients of STEMI who underwent CAG which met inclusion and exclusion criteria. Study subjects were divided into two groups on basis of having reciprocal changes in ECG. They underwent CAG and the findings were calculated with the Gensini score to see the severity of the patients. Gensini score value 36 was chosen as an appropriate cut-off value and patients was divided into 2 groups, those with a Gensini score <36 points (absent or mild coronary atherosclerosis), and those with a Gensini score >36 points (moderate to severe coronary atherosclerosis).

Results:With Gensini score among both groups, the severity of lesion were more in Group I patients having reciprocal changes which was considered >36 by gensini score which was 8 patients in group I.

**Conclusion:** This study found that patient with inferior STEMI with reciprocal changes (ECG) showed angiographically more severe CAD compared to patients without reciprocal changes.


**Keywords:** ST elevated myocardial infarction, STEMI,Reciprocal ST depression.

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## Introduction:

ST-segment elevation myocardial infarction (STEMI) is a significant health problem in industrialized countries and is becoming an increasingly significant problem in developing countries. Approximately 40 percent of myocardial infarctions involve the inferior wall. Reciprocal ST-segment depression during acute myocardial infarction is a common finding occurring in about 54-82 %[1]. Recent data indicates that coronary artery disease prevalence is 1.85% to 3.4% in rural population and it is 19.6% in urban population in Bangladesh[2]. All acute STEMI events result from

1. Resident, Department of Cardiology, University Cardiac Center (UCC), Bangabandhu Sheikh Mujib Medical University, Dhaka (BSMMU), Dhaka, Bangladesh.
2. Associate Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
3. Associate Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
4. Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
5. Professor, Department of Cardiology, UCC, BSMMU, Dhaka, Bangladesh.
6. Resident, Department of Cardiology, University Cardiac Center (UCC), Bangabandhu Sheikh Mujib Medical University, Dhaka (BSMMU), Dhaka, Bangladesh.
7. Associate Professor and head of the Department of Cardiology, Uttara Adhunik Medical College and Hospital, Dhaka, Bangladesh.

**Address of Correspondence**: Dr. Amit Mishra, Resident, Department of Cardiology, University Cardiac Center (UCC), Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.

coronary atherosclerosis, generally with superimposed coronary thrombosis caused by rupture of an atherosclerotic lesion[8]. Coronary Artery Disease (CAD) is the foremost single cause of mortality and loss of Disability Adjusted Life Years globally. A large percentage of this burden is found in low and middle income countries. This accounts for nearly 7 million deaths and 129 million DALYs annually and is a huge global economic burden[3].

ST-segment elevation myocardial infarction (STEMI) is a serious manifestation of coronary artery disease which is typically caused by the rupture of an atherosclerotic plaque leading to ischemia and necrosis of downstream myocardium. Early revascularization coronary artery is the major therapeutic goal. Mortality from STEMI was significantly reduced during the last decades. Still the risk of recurrent adverse cardiovascular events remains substantial and may vary significantly across different subgroups of STEMI patients. Early risk assessment for the individual patient is of paramount importance and may help to optimize medical management[4].

South Asians including Bangladeshi patients have been found to have a higher proportional mortality rate from ischemic heart disease compared with other Asian ethnic groups mainly people with low socioeconomic condition take service from the inpatient department of the hospital. So the exact picture is not known[5]. Inferior wall myocardial infarction (MI) occurs from a coronary artery occlusion with resultant decreased perfusion to that region of the myocardium. In most patients, the inferior myocardium is supplied by the right coronary artery. In about 6-10% of the population, because of left dominance, the left circumflex will supply the posterior descending coronary artery. However, several complicating factors can lead to increased mortality, Inferior wall MIs are estimated to be 40% to 50% of all MIs. They have a better prognosis than other myocardial infarctions, with a mortality of 2% to 9%.9[23]. 70 – 97.2% of patients with inferior wall MI had reciprocal changes in aVL.3 Classical studies of ST-elevation myocardial infarction show reciprocal depression ≥0.1 mV in approximately 60% of inferior infarctions and 30% of anterior infarctions[6].

Reciprocal change is an important ECG concept to consider for two reasons. First, it identifies patients with a high-risk ACS presentation. Reciprocal change in the setting of STEMI identifies a patient with an increased likelihood of cardiovascular complication (heart block, malignant ventricular dysrhythmia, cardiogenic shock) and poor outcome (significant left ventricular dysfunction, death). Second, the presence of reciprocal change is strong confirmatory evidence that STEMI is present and has both very high specificity and a positive predictive value greater than 90%[7,8]. The significance of reciprocal ST segment depression during acute myocardial infarction has been an area of debate, whether it is a sign of multivessel disease, ischemia at a distance or merely a benign electrical phenomenon[9].

The Gensini score was developed by Gensini and takes into consideration the geometrical severity of lesions by angiography, the cumulative effects of multiple obstructions and the significance of jeopardized myocardium .[10] Moreover, research on clinical course and angiographic severity of AMI inferior with reciprocal ECG changes in our racial background is very few. Recognizing these limitations, the present study has been planned to compare the clinical course and angiographic severity of CAD in AMI inferior patients having reciprocal ECG changes to those without such changes.

**Methods:**

This observational cross-sectional study was conducted at the Department of Cardiology, Bangabandhu Sheikh Mujib Medical University, Dhaka. The center has consistently been ranked as the one of the top hospitals in Bangladesh. Total duration was 10 march 2020 to 31st December 2020. We studied 48 adult patients (age ≥18 years) with acute STEMI (inferior) admitted in CCU undergoing Coronary Angiogram(CAG). Patients were divided into two groups on the basis of having reciprocal changes or not. Exclusion criteria considered as patients with history of ECG evidence of previous myocardial infarction including both anterior or inferior MI, ECG showing ventricular paced beats, LBBB. The protocol was approved by the local ethics committee and Institutional Review Board (IRB). Written informed consent was obtained from each patient after careful explanation.

A total of 48 patients (24 in each group) was included in the study as per inclusion and exclusion criteria who were admitted in CCU and was diagnosed STEMI inferior with or without reciprocal changes. They were divided into two groups: STEMI Inferior having reciprocal ST segment changes (Group-I) and no changes in ECG with STEMI Inferior (Group-II), each group contained 24 patients. Interpretation of coronary angiogram was done by visual estimation by two cardiologists to assess the severity of coronary artery disease. Severity of coronary stenosis graded according to the number of major epicardial vessel with significant stenosis (vessel score) and Gensini score. From the categorical viewpoint, significant coronary artery disease defined as > 70% stenosis in any of the three major epicardial coronary arteries or a left main coronary artery stenosis > 50%. Angiograms revealing coronary artery stenosis < 70% in major epicardial coronary arteries considered as non-obstructive CAD. Extent of coronary artery disease defined as significant single, two or three vessel coronary artery disease (Chaitman et al., 1981). The Gensini score was developed by Gensini and takes into consideration the geometrical severity of lesions by angiography, the cumulative effects of multiple obstructions and the significance of jeopardized myocardium. Gensini score value 36 will be chosen as an appropriate cut-off value and patients with a Gensini score <36 points considered as absent or mild coronary atherosclerosis, and those with a Gensini score >36 points considered as moderate to severe coronary atherosclerosis[11].

After collection of all information, these data were checked, verified for consistency and edited for finalized result. Statistical analyses were carried out by using the Statistical Package for Social Sciences (SPSS) version 23.0 for Windows Software. Continuous data were expressed as mean ± standard deviation (SD) and categorical data were expressed as frequency and percentages. Mean and standard deviation were computed for quantitative variables and was analyzed by unpaired t-test. The correlation of Coronary Angiogram Severity with the Gensini score was done by Pearson's correlation coefficient test. P values <0.05 was considered as statistically significant.

**Results:**

This comparative study was grouped into two group based on reciprocal changes seen in ECG.Group I with reciprocal changes had 24 patients while group II with no changes was group II which also included 24 patients. Total of 48 patients with or without changes underwent coronary angiogram were enrolled in the study. Then findings were compared between two study Groups. Table I represents the age & sex of the study population where the age is less than 50 is only 4 patients which is in Group I while between 51-60 is 12 (50.0%) in Group I and 11 (45.8%) in Group II while more than 60 are 8 (33.3%) in Group I and 13 (54.2%) in Group II. Whereas all the patients were male in Group I and 3 female patients were in Group I.

The mean age of the participants of group I and group II were 52.6 ± 7.53 and 57.34±8.56 years respectively. A male predominance (100% vs 87.5%) was observed in either group. Physical examination among the defined study population where the pulse, respiratory rate and systolic blood pressure as well as diastolic blood pressure and BMI if remains adequately controlled helps in favorable outcome in management.as well as diagnosing other associated features. table IV shows that radial pulse, respiratory rate, systolic blood pressure and diastolic blood pressure were not statistically significant (p>0.05) between two groups. . Majority of the patients in both groups were overweight and obese and statistically significant. BMI>23 is considered overweight in Asian.

Most of the patients had various risk factors. smoking was the most prevalent risk factor in both groups (100.0% vs 91.7%). Hypertension took the second leading position. Distribution of risk factors among the study subjects were Hypertension (83.3% vs 91.7%), Diabetes Mallitus (91.7% vs 66.7%), Dyslipidemia (91.6% vs 58.3),Chronic kidney disease (41.7% vs 12.5%). No cases found to be anaemic.All subjects had haemoglobin more than 10 gm/dl.

ECG remain easy and quickest method in diagnosing STEMI while other lab findings may gave us clue in assessing severity of the lesion. Table II shows that 24(100.0%) patients was found reciprocal changes in group I and not found in group II which was statistically significant (p<0.05), among the reciprocal changes in lead I and aVL were 16 and 18 patients in both the group while ST depression was noticed in V1-V6 in few patients among them more were noticed in V2,V3.

Echocardiography remains important tool in estimating the loss of viable myocardium and severity of stenosis, hence it remains important tool for the physicians to assess the overall condition prior to go to cathlab table. Table 3 shows that most of the patients had > 45% left ventricular ejection fraction (LVEF). Out of 48 patients, 46 patients had inferior wall hypokinetic (100.0% vs 91.7%) and only 2 patients had lateral wall hypokinesia and 1 patient had anterior wall hypokinesia in group I.

Table 4 revealed Single vessel disease (SVD) was more common in group-II (54.16%) than group I (87.5%) but the difference was statistically not significant (p=0.11). Double vessel disease (DVD) more common in group I (41.6%).Only one patient (4.16%) found to be have Triple vessel disease(TVD). On CAG we did not find any significance of no of vessels involved but the coronary vessel was also not significant but LAD was involved more when compared to LCX.

While calculating the Gensini score patients with reciprocal changes had Gensini score more when compared to the other group without changes. Table 5 shows that 8(33.3%) patients had Gensini score ≥36 (moderate to severe coronary atherosclerosis) in group I and 2(8.3%) in group II. The mean Gensini score was 43.57±12.41 in group I and 32.68±11.46 in group II. The difference was statistically significant ($p<0.05$) between two groups.

Regressional analysis (Table-6) was done with the significant markers. Hence, it was found that obesity and elevated serum creatinine along with high Gensini score had important impact on reciprocal ST segment changes. Delicate control of these risk factors within normal limit may be helpful for the patients with reciprocal changes.

**Table-I**

*Associations of the various demographic, clinical, biochemical and echocardiographic variables between groups of study patients (N=48)*

| Variables | Group I (n=24) mean±SD or No. (%) | Group II (n=24) mean±SD or No. (%) | Total | P Value |
|---|---|---|---|---|
| Age (year) | 55.6±7.53 | 57.34±8.56 | | $^{a}0.458^{ns}$ |
| Sex | | | | |
| Male | 24 (100.0%) | 21 (87.5%) | 45 | $0.17^{ns}$ |
| Female | 0 (0.0%) | 3 (12.5%) | 3 | |
| BMI | | | | |
| Normal | 16 (66.7%) | 4 (16.7%) | 20 | |
| Over weight | 6 (25.0%) | 15 (62.5%) | 21 | $0.002^{s}$ |
| Obese | 2 (8.3%) | 5 (20.8%) | 7 | |
| Diabetes mellitus | 22 (91.7%) | 16 (66.7%) | 38 | $0.04^{s}$ |
| Hypertension | 20 (83.3%) | 22 (91.7%) | 42 | $0.39^{ns}$ |
| Smoking | 24 (100.0%) | 22 (91.7%) | 46 | $0.28^{ns}$ |
| Dyslipidemia | 22(91.6%) | 14(58..3%) | 36 | $0.425^{ns}$ |
| Clinical features | | | | |
| Chest pain | 22 (91.7%) | 24 (100.0%) | 46 | $0.28^{ns}$ |
| Dyspnoea | 3 (12.5%) | 0 (0.0%) | 3 | $0.17^{ns}$ |
| Palpitation | 8 (33.3%) | 4 (16.7%) | 12 | $0.18^{ns}$ |
| Radial pulse (>100 beats/minute) | 6 (25.0%) | 1 (4.2%) | 7 | $0.07^{ns}$ |
| Respiratory rate (>20 breath/minute) | 2 (8.3%) | 0 (0.0%) | 2 | $0.28^{ns}$ |
| Lab diagnosis | | | | |
| Hemoglobin >10 g/dl | 24 (100.0%) | 24 (100.0%) | 48 | $1.0^{ns}$ |
| Serum creatinine (mg/dl) | | | | |
| <1.5 | 14 (58.3%) | 21 (87.5%) | 35 | $0.03^{s}$ |
| >1.5 | 10 (41.7%) | 3 (12.5%) | 13 | |

P value reached from Chi-square test.BMI=Body Mass Index, CAD=Coronary Artery Disease, HDL-C=High Density Lipoprotein-Cholesterol, LDL-C=Low Density Lipoprotein-Cholesterol, LVEF=Left Ventricular Ejection Fraction, SBP=Systolic Blood Pressure, SOB= shortness of breath, s=significant, ns=not significant.

**Table-II**

*\Comparison of ECG findings (reciprocal changes) between groups (n=48)*

| Variables | Group I(n=24) No.(%) | Group II (n=24) No.(%) | Total | P Value |
|---|---|---|---|---|
| ECG | | | | |
| ST Elevation | 24 (100.0%) | 24 (100.0%) | 48 | 1.0[ns] |
| Ï%Reciprocal changes | 24 (100.0%) | 0 (0.0%) | 24 | <0.001[s] |
| Reciprocal changes in I&aVL | 6(66.7%) | 18(75.0%) | | 0.52ns |
| Reciprocal changes in V1-V6 | 08(33.3%) | 06(25.0%) | | |

**Table-III**

*Echocardiography findings of the study groups (N=48)*

| Echocardiography | Group-I(n=24) | Group-II(n=24) | Total | P value |
|---|---|---|---|---|
| LVEF (%) | | | | 0.08[ns] |
| | >45 | 19 (79.2%) | 24 (100.0%) | 43 |
| | <45 | 5 (20.8%) | 0 (0.0%) | 5 |
| Regional wall Hypokinesia | | | | |
| Inferior wall | 24 (100.0%) | 22 (91.7%) | 46 | 0.28[ns] |
| Lateral wall | 2 (8.3%) | 0 (0.0%) | 2 | 0.28[ns] |
| Anterior wall | 1 (4.2%) | 0 (0.0%) | 1 | 0.49[ns] |

ns=not significant, P value reached from Chi-square test

**Table-IV**

*Coronary angiography findings of the study groups (N=48)*

| Coronary angiography | Group-I (n=24) | Group-II (n=24) | Total | P value |
|---|---|---|---|---|
| Significant CAD | 24 (100.0%) | 24 (100.0%) | 48 | 1.0[ns] |
| No of vessel involved | | | | |
| SVD | 13 (54.16%) | 21 (87.5%) | 44 | 0.11[ns] |
| DVD | 10 (41.66%) | 3 (12.5%) | 3 | 0.22[ns] |
| TVD | 1 (4.16%) | 0 (0.0%) | 1 | 0.50[ns] |
| Coronary vessel involved | | | | |
| LAD | 7 (29.16%) | 2 (8.33%) | 2 | 0.07[ns] |
| LCX | | 3 (12.5%) | 1 (4.16%) | 4 0.30[ns] |
| RCA | 24 (100.0%) | 21 (87.5%) | 48 | 0.12[ns] |

SVD=Single vessel disease, DVD=Double vessel disease, TVD=Triple vessel disease, LAD=Left Anterior Descending, LCX=Left Circumflex, RCA=Right Coronary Artery, ns=not significant, P value reached from Chi-square test

**Table-V**

*Coronary angiography findings of the study groups (N=48)*

| Gensini score | Group-I (n=24) | Group-II (n=24) | Total | P value |
|---|---|---|---|---|
| <36 16 (66.7%) | 22 (91.7%) | 38 | <36 | |
| ≥36 8 (33.3%) | 2 (8.3%) | 10 | e™36 | |
| Mean±SD | 43.57±12.41 | 32.68±11.46 | | <0.001[s] |

s= significant, P value reached from unpaired t-test

**Table-VI**

*Independent Risk factor analysis by multivariate logistic regression for STEMI inferior having reciprocal ST segment changes (n=48)*

| Risk factors | Regression coefficient β | Odds Ratio (OR) | 95% CI for OR | P value |
|---|---|---|---|---|
| Obese | -3.035 | 0.048 | 0.003-0.697 | 0.026[s] |
| Diabetes mellitus | 1.527 | 4.603 | 0.563-37.624 | 0.154[ns] |
| Serum creatinine | 2.266 | 9.639 | 1.363-68.143 | 0.023[s] |
| Triglyceride (1.69-2.25 mmol/L) | 20.745 | 1.022 | 0.031-79.540 | 0.999ns |
| Gensini score (e™36) | 2.766 | 15.903 | 1.075-23.270 | 0.044s |

s= significant, ns= not significant, P-value reached from multivariate analysis by binary logistic regression analysis

**Discussion:**

In this single-centered cross- sectional study, a total of 48 patients underwent CAG and calculated through Gensini score to assess the severity of coronary artery disease.

The mean age of study subjects was 55.6±7.53 years in group I & 57.34±8.56 years in group II which was significantly younger than previous western studies done on 2017[10]. According to another study reported on 2017 that the mean age of ACS patients in Bangladesh was 57.8±12.1 (range 21-97) years which are almost comparable to current study[5]. A male predominance (100% in group I and 87.5% in group II; p=0.17) was observed in both groups which was higher than previous studies[13]. The mean age of the patient groups was 57.0±9.1 years. And Cader et al, 2017 (71.4% of ACS patients in Bangladesh were male)[5]. The reason for male predominance in this study can be explained by a higher proportion of male patients admitted in the context of Bangladesh, and a handful of female patients underwent CAG due to inadequate financial support.

BMI with normal weight was 66.7% in group I patients while 16.7% in group II. While overweight & obese patients were higher in group II (62.5%, 20.8%) in comparison to group I which were similar statistically(P=0.002) but was lesser than an early study.[17] (Mean BMI of subjects with normal angiographic findings was 20.81 ± 1.03 kg/m2 The mean BMI of single, double and triple vessel disease were 23.85 ± 2.24, 24.25 ± 2.41 and 32.06 ± 7.86 kg/m2 respectively. A study reported that the mean BMI of ACS patient in Bangladesh was 25.6±3.7 kg/$m^2$,which is comparable to our study[5]. This reflects the overweight population are vulnerable to developing ACS and weight reduction measures should be practiced for the prevention of the coronary artery disease (CAD).

Overall hypertension was the most prevalent risk factor between 2 study groups. Hypertensive patients were more having SBP>160 in group I (58.3%) than group II which is 16.7% having p value of 0.010. Distributions of other factors were almost identical between the study groups except heart failure which were more in Group I patients having reciprocal changes. In this study, dyslipidemia, smoking, 95.8%, 100% respectively and renal insufficiency with serum creatinine less than 1.5 being 58.3%and more than 1.5mg/dl being 41.7%. In group I and 100%, 91.7%, and renal insufficiency being 87.5% and 12.5% in group II respectively (p=0.858, p=0.49, p=0.28, p=0.03).Another study showed that there is no significant statistical difference in both studied groups according to the major risk factors including (HTN, smoking, dyslipidemia and renal insuffiency[14].

The majority of the patients in either group presented with STEMI. Ahmed et al, 2018 has reported that among ACS patients in Bangladesh, presentation with STEMI, were 63.6%,which are comparable to our study. This study reflects that STEMI is the most common presentation of ACS in patients of Bangladesh. HbA1c at baseline was found more than 6.5% in 66.7% in group I patients and 75% in group II patients while more than 7 which is poorly controlled was more in group II patients with (P=<0.52) which is non-significant to study done on 2012[15].

Cader et al, 2017 reported that among 1914 ACS patients in Bangladesh mean HbA1c was 12.7±1.7% and creatinine was 1.4±0.9 mg/dl[16]. The inconsistency regarding HbA1c value and serum creatinine can be explained by different enrollment criteria and baseline characteristics, and relatively small sample size in our study. In this study, number of coronary vessels involved like SVD, DVD, and TVD were 54.16%, 41.66% and 4.16% respectively in patients of group I while group II patients had 87.5%,12.5% and 0.00% respectively. SVD was observed significantly higher in group II. And DVD and TVD was overserved in group I patients. Whereas LAD lesion was 29.16% vs 8.33%, LCX lesion were 12.5% vs 4.16% and RCA lesion was found 100% vs87.5%. El Atroush et al, 2012 demonstrated a significant statistical difference with a P value of 0.001 was found between the two studied groups as regard the presence of LAD lesion as 14 patients (70%) in group 1 had a LAD lesion while four patients (20%) in group 2 had a LAD lesion[17,18], which did not match to this study which as only 7 patients having LAD lesion in group I while 2 patients in group II while 3 patients having LCX lesion in group I vs 1 patient in group II and one TVD in group I only .

This study showed almost 8(33.3%) patients had Gensini score $\geq$36 (moderate to severe coronary atherosclerosis). Mean Gensini score was found to have43.57±12.41. Salla et al (2017) reported that mean Gensini score in patients with coronary artery disease is 41.14.[19,20] Which was comparable to our findings. The mean Gensini score was 43.57±12.41 in group I and 32.68±11.46 in group II. The difference was statistically significant ($p<0.05$) between two groups. Regression analysis was done with outcome variables were compared to see the risk estimation for angiographic severity where obesity, elevated serum creatinine and Gensini score was consistent for the result. Which were for obesity, serum creatinine Gensini score was with the p value 0.026,0.023 and 0.044.

In the current study the degree of ST segment elevation in the inferior leads on admission was significantly higher in group 1 (0.72± 0.25) than in group 2 (0.41± 0.14) with P-value <0.001. The significance of reciprocal ST depression on the electrocardiogram (ECG) during the course of inferior myocardial infarction (MI) remains uncertain, opinion is divided as to whether it is a benign electrical phenomenon or a sign of a greater myocardial necrosis and more frequently we found that certain features like smoking, poor BMI and HTN, dyslipidemia with reciprocal changes are considered highly risky patients in comparison to without reciprocal change[21,22,23].

### Limitations:

The sample was taken from a single center. Result of the study might be influenced by relatively smaller sample size. The study sample was taken consecutively (non-randomly) which might have affected the outcome of the study.There is no previous study comparing angiographic severity of patients with STEMI inferior with or without ST reciprocal changes in Bangladesh, making it difficult to compare with this result.

### Conclusion:

In conclusion, these data suggest that that patient with Inferior STEMI with reciprocal changes shows angiographically more severe CAD than without reciprocal ST change on ECG.

### Conflict of interest:

Authors declare no conflicts of interest.

### References:


1. Ahmed M, Rubaiyat K.A, Saleh MAD, Chowdhury AW, Khuda CKE, Ferdous KAF, Hasan N, Hoque ATMM, Islam KN, Amin MG. Clinical Characteristics and Angiographic Profile of Acute Coronary Syndrome Patients in a Tertiary Hospital of Bangladesh. Bangladesh Heart Journal, 2018;33(1):10-15.
2. Atroush EL, Effat H, Shehata M, Emara H. Reciprocal ST Segment changes in acute inferior myocardial infarction: Clinical, hemodynamic and angiographic implications. The Egyptian Heart Journal. 2012; 64(3): 97-103.
3. Birnbaum Y, Sclarovsky S, Mager A, Strasberg B, Rechavia E. ST segment depression in aVL: a sensitive marker for acute inferior myocardial infarction. European heart journal, 1993; 14(1):4-7.
4. Brady WJ, Perron AD, Martin ML, et al. Electrocardiographic ST segment elevation in emergency department chest pain center patients: etiology responsible for the ST segment abnormality. Am J Emerg Med. 2001;19:25-28.
5. Cader FA, Haq MM, Nasrin S, Kabir CS. Presentation, Management Practices and In-hospital Outcomes of Patients with Acute Coronary Syndrome in a Tertiary Cardiac Centre in Bangladesh. Bangladesh Heart Journal, 2017; 32(2): 106-113.
6. Chaitman BR, Bourassa, MG, Davis, K, Rogers, WJ, Tyras, DH. et al. 'Angiographic prevalence of high-risk coronary artery disease in patient subsets (CASS)' Circulation, 1981;.64:360-367.
7. Cinca J, Noriega FJ, Jorge E, Garcia JA,Amoros G, Arzamend D. ST-segment deviation behavior during acute myocardial ischemia in opposite ventriular regions: Observations in the intact and perfused heart. Heart Rhythm.2014 Nov; 2084-2091.
8. Falk E, Nakano M, Bentzon JF, Finn AV, Virmani R. Update on acute coronary syndromes: the pathologists' view. European heart journal. 2013; 34(10):.719-28.

9. Gensini GG. A more meaningful scoring system for determining the severity of coronary heart disease. Am J cardiol. 1983;51:606.

10. Hwang JK, Lee SH, Song YB, Ahn J, Carriere K, Jang MJ, Park, TK, Choi SH, Yang JH, Lee SH. Glycemic control status after percutaneous coronary intervention and long-term clinical outcomes in patients with type 2 diabetes mellitus. Circulation: Cardiovascular Interventions. 2017; 10(4):e004157.

11. Islam AM, Majumder, AAS. Coronary artery disease in Bangladesh: A review. Indian heart journal. 2013; 65(4):424-435.

12. Karap1nar, H, Yanarta_ M, Karaveliolu Y, Kay Z, Kaya H, Pala S, Emirolu MY, Y1lmaz A. Importance of reciprocal ST segment depression in the extensive coronary artery disease. European Journal of General Medicine. 2013; 7(1):88-91.

13. Karim MA, Majumder AAS, Islam KQ, Alam MB, Paul ML, Islam MS, Chowdhury KN, Islam SMS. Risk factors and in-hospital outcome of acute ST segment elevation myocardial infarction in young Bangladeshi adults. BMC cardiovascular disorders.2015; 15(1):1-8.

14. Kassaian S.E, Goodarzynejad H, Boroumand MA, Salarifar M, Masoudkabir F, Mohajeri-Tehrani MR, Pourhoseini H, Sadeghian S, Ramezanpour, N, Alidoosti M, Hakki E. Glycosylated hemoglobin (HbA1c) levels and clinical outcomes in diabetic patients following coronary artery stenting. Cardiovascular diabetology2012; 11(1): 82.

15. Nour MK. Significance of reciprocal ST segment depression in ST elevation myocardial infarction. The Egyptian Journal of Critical Care Medicine. 2012; 5(1):23-27.

16. Otto LA, Aufderheide TP. Evaluation of ST segment elevation criteria for the prehospital electrocardiographic diagnosis of acute myocardial infarction. Ann Emerg Med. 1994;23:17-24.

17. Rafiquzzaman K, Ali M, Rahman MT, Alam N, Hossain MA, Jafar AHM, Rahman MA. Association of Body Mass Index with Angiographic Severity of Coronary Artery Disease in Patients with Acute ST-Segment Elevation Myocardial Infarction. Cardiovascular Journal. 2017; 10(1):68-73.

18. Ralapanawa U, Sivakanesan, R, 2021. Epidemiology and the Magnitude of Coronary Artery Disease and Acute Coronary Syndrome: A Narrative Review. Journal of Epidemiology and Global Health.

19. Salla S.P, Patchipala R, Paidi S, Relationship between Serum Vitamin D Level and Angiographic Severity in Coronary Artery Disease. Journal of Evidence Based Medicine and Healthcare. 2017; 4(22):1260-65.

20. Ullah M, Saha SK, Rahman MT, Karim MA, Ahmed R. Cardiovascular Risk Factors in Patients with Acute MI in a Secondary Hospital in Bangladesh. Cardiovascular Journal. 2020; 12(2):96-101.

21. Vaidya GN, Antoine S, Imam SH, Kozman H, Smulyan H, Villarreal D.. Reciprocal ST-segment changes in myocardial infarction: ischemia at distance versus Mirror reflection of ST-elevation. The American journal of the medical sciences. 2018; 355(2):162-167.

22. Vogel B, Claessen B.E, Arnold SV, Chan D, Cohen DJ, Giannitsis E, Gibson CM, Goto S, Katus HA, Kerneis M, Kimura T. ST-segment elevation myocardial infarction. Nature Reviews Disease Primers. 2019;5(1):1-20.

23. Warner MJ, Tivakaran VS. Inferior Myocardial Infarction. 2021 Jan 1. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan–. PMID: 29262146.

REVIEW ARTICLE

# Rotational atherectomy: Current Prospective

Shuvanan Ray[1], Sounak Ray[2]

**Abstract:**
After its introduction as an instrument for debulking, rotational atherectomy was out of favour for nearly a decade due to high periprocedural complications and restenosis. It re-emerged as an essential tool for plaque modification in calcified lesions before drug eluting stent implantation. All that became possible with changing procedural rules e.g. lowering burr: artery ratio (<0.6), and speed (<150000) using slow pecking motion of the burr. Use of modified balloons (cutting balloons, scoring balloons, opn) have reduced the major procedural complications and long term major advanced cardiac events significantly after implantation of newer drug eluding stents.

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**Principle of rotational atherectomy:**

Percutaneous coronary intervention started as a revolution in the treatment of coronary artery disease about 40 years ago. Initially the plane balloon angioplasty (POBA) was very selective and was limited to focal non calcified lesions in the proximal coronary arteries[1].

then came the second revolution in the form of coronary stents Which addressed the problems of dissection and elastic recoil after POBA but gave birth to a new disease called in stent restenosis[2]. In patients with long lesions, small vessel diameters, bifurcation lesions, diabetics, chronic renal failure, chronic total occlusion(CTO) and saphenous grafts (SVG) word particularly prone to develop ISR are which could not be overcome by modifying stand designs all through adjunct pharmacological treatment.

Animal and intravascular ultrasound (IVUS) studies in humans have shown that the primary pathological process in ISR is neointimal proliferation [(3,4,5)]. in addition to the deep arterial wall trauma and non-healing of the foreign element (Stent struts), residual plaque burden remaining outside the stent are directly proportional to the amount of neointimal proliferation [(6)]. Theoretically mechanical debulking of the atherosclerotic plaques prior to stenting seemed attractive because of i) decrease in plaque volume before stenting ii) bigger lumen diameter gain (MLD) iii) Reduced complication because of preservation of the original arterial size and decreased barotrauma to the vessel[7].

The rotational atherectomy was first introduced for the purpose of mechanical debulking of the plaque by David Auth and colleagues in 1988[8]. After initial adoption, the enthusiasm for rotational atherectomy died down after reports of high restenosis rates in the previous DES era[9,10,11].

While the rotational atherectomy procedure was initially reserved for the treatment of discrete non calcified plaques, gradually with improved technical development and knowledge the procedure was applied to more complex lesions. A major limitation of POBA and stent placement remains the inability to dilate certain types of lesions. This is particularly found in heavily calcified lesions. Even with high pressure inflation sometimes they do not yield, moreover angioplasty balloons are prone to asymmetric expansion, dog boning around the site of severe calcification, increasing the risk of coronary dissection and perforation[12,13]. Calcified plaques impede delivery of angioplasty balloons and stents and increase the risk of stent under expansion and malapposition [(14,15)] leading to stent thrombosis and restenosis .

Several observational studies have confirmed that rotational atherectomy (RA) prior to stent deployment in severely calcified lesions does facilitate stent delivery and expansion but the incidence of restenosis remains unsatisfactory (23%) with stent implantation[16,17].

**1.** Consultant, Fortis Hospital Anandapur, Kolkata, India
2. ESI Hospital, Sealdah, Kolkata, India.

**Address of Correspondence:** Dr. Shuvanan Ray, Consultant, Fortis Hospital Anandapur, Kolkata. Mobile: +9830024266, Email: shuvananray@gmail.com

Then came the era of drug eluting stent (DES) when the neointimal proliferation was significantly inhibited after stent implantation and TLR rates were reduced [(18,19)]. Several studies have reported favourable intermediate and long-term outcomes with adjunctive DES implantation[20,21].

The RA prior to Taxus stent treatment for complex native coronary artery disease (ROTAXUS) trial randomised 240 patients with complex calcified coronary artery disease in a 1:1 ratio to RA versus conventional balloon angioplasty prior to paclitaxel eluting stent (Taxus) implantation. Reference vessel diameter was same in both groups (3.1 ± 0.3mm). RA was done using burr size (1.5 ± 0.2) and only 5.5% required more than one burr. total stent length was not different (27.7± 12.2 vs 25.2 ± 11.5mm). There was a higher strategy success in the RA group (92.5% versus 83.3%) and higher crossover in the standard therapy group. Despite an initial higher acute lumen gain (1.5 ± 0.43 vs 1.44 ±0.49 mm, p= 0.01) with RA in stent late lumen loss was higher in the RA group (0.4 ± 40.58 versus 0.31 ± 0.52, p=0.04). In stent binary restenosis, TLR, definite stent thrombosis, MACE rates were similar in two groups. In this trial RA was used to reduce plaque burden by debulking and the initial gain by that principle did not translate into long term clinical success. European expert consensus on rotational atherectomy [(23)] in 2015 introduced a standard protocol for RA in which it was stated that the contemporary objective of RA was plaque modification. In most of the cases, the simple passage of a single burr is sufficient to smoothen the vessel lumen or to disrupt the continuity off the intravascular calcium rings, to enable subsequent balloon dilation and stent implantation. The concept of plaque modification (not ablation) before DES implantation changed the scenario of RA in current era, particularly with the second-generation drug eluting stents. Vaquerizo B. et al.[24] used smallest burr size thought to be necessary (burr: artery 0.5) with the intention of altering plaque structure and compliance by its characteristic ‘differential cutting ‘which subsequently enabled adequate balloon expansion before stenting rather than to decrease plaque mass (debulking). This smaller bar use reduced the chance of vessel inflammation and vessel wall trauma[25, 26]. This strategy showed excellent mid-term outcomes with only 3.4% TLR and 2.1% stent thrombosis.

**Technical advancements:**

- Guide catheter - Technical advancement allowed the RA Procedure simpler and smooth. The guide catheter technology now allows a standard 6F guide catheter to house burr size up to 1.7mm. For burr sizes ≥2mm a 7F or larger systems are required. Therefore, most cases requiring RA can be performed with radial access, thereby reducing access complication and incidence of stroke.
- Wiring- The Rota wire (Boston Scientific) is available in two versions, the Rota floppy and extra support. Both wires are 325 cm long, permitting over the wire exchanges and are 0.009 inches in diameter, tapering to 0.005 inches before terminating in a 0.014-inch spring tip. The floppy wire is more flexible with a longer taper (over 13 cm) and shorter 2.2 cm spring tip, causing less vessel straightening and wire bias and permits navigation at the greater curvature of angulated lesions. About 95% of the RA procedure can be completed with Rota floppy wire.
- Sizing & Movement - As mentioned above, plaque modification before stent implantation being the order of the day, a single burr (burr to artery ≤0.6) is sufficient for most of the vessels.

  Pecking motion of the burr- A quick push forward/ pullback movement Is the most widely recommended motion pattern. The pecking motion minimises the deceleration of rota burr and allow shortening of the duration of individual runs (recommended <30 seconds). The ideal speed is recommended to be 1,40,000 to 1,80,000 rpm, with higher speeds link to greater platelet activation. Though a recent study did not have any difference in incidents of slow flow or periprocedural MI at high speed (1,90,000 rpm) RA[27].

  Our recent study showed that in severely calcified lesions, high speed RA can lead to increased MACE during the hospital stay. So, in most of the centres, medium speed (1,50,000 rpm) is adopted for the safety of the procedure[28].
- Flush cocktail- When the rota burr is advanced, there is generation of heat leading to platelet activation, to combat that a pressurised solution is perfused through the side port of the advancer. Traditional flush cocktail included Rota glide, a vessel dilator and heparin. Recent consensus statement recommends a flush solution comprising of

heparinised Normal saline (3000 IU heparin for 1L of saline) reserving vasodilators for provisional use[29].

- Temporary pacing - Traditionally temporary pacing was recommended during the rotablation of the right coronary artery or dominant left circumflex artery due to concerns for transient conduction defect by microembolization. Refinement off the procedure enabled the operators to complete the procedure without mandatory temporary pacing in most of the cases. IV aminophylline 250-300mg over 10 minutes or IV atropine 0.4-1mg Every 3-5 minutes can take care of most of the bradycardia episodes.

**Summary of optimal RA technique**

- Single burr with burr to artery ratio ≤0.6
- Rotational speed of ≤150000 rpm
- Slow pecking motion of the burr.
- Short ablation runs of 15-20 seconds
- Avoid deceleration ≥5000 rpm
- Final polishing run
- Low heparin cocktail (3000 in 1Ltr of NS)
- Scoring Balloon/ Cutting Balloon (1:1) to be used for plaque modification after RA.

**Conclusion:**

RA has travelled a long way to become a niche procedure in current practice of percutaneous coronary interventions. Using a single small burr in severely calcified coronary artery followed by scoring or cutting balloon for plaque modification has opened the vista for current generation of drug eluting stents to have excellent clinical results. A recent study in our subcontinent has shown a very acceptable in hospital and midterm results (procedural success 96.52% and MACE rate 4.28%)[30].

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**References:**


1. Meir B, Bachman D, Fischer AT:25 years of coronary angioplasty: Almost a fairy tale: Lancet: Feb:08;361(9356):527,2003
2. Kastrati A, Mehilli J, Dirschinger J et al: Restenosis after coronary placement of various stent types: Am J Cardiol: 87:34-39:2001
3. Schwartz RS, Huber, Murphy JG et al: Restenosis and the proportional neointimal response to coronary artery injury; Results in a porcine model: J Am. Coll. Cardiol,19, 267-274, 1992
4. Karas S P, Gravanis M B, Santoian E C et al coronary intimal proliferation after balloon injury and stenting in swine. An animal model of restonsis: J Am Coll.Cardiol:20:467-474,1992
5. Hoffmann R, Mintz G S, Dussaillant GR et al Patterns and mechanisms of in stent restenosis. A serial intravascular ultrasound study: Circulation: 94: 1247-1254,1996
6. Prati F, Di Mario C. Moussa I, et al: Instent neointimal proliferation correlates with the amount of residual plaque burden outside the stent: An intravascular ultrasound study: Circulation:99;1011-1014,1999
7. Kovach J A, , Mintz G S, Pichard A D et al: Sequential Intravascular ultrasound characterization of the mechanisms of rotational atherectomy and adjunct balloon angioplasty: J Am Coll. Cardiol:22:1024-32:1993
8. Hansen DD, Auth DC, Vracko R, Ritchie JL: Rotational atherectomy in rabbit iliac arteries Am H J, 115:160-5:1988
9. Moussa I, Di Mario C, Moses J et al: Coronary stenting after rotational atherectomy in calcified and complex lesions: Angiographic ad clinical follow up results: Circulation 96:128-36:1997
10. Reifart N, Vardomael M, Krajcar M et al: Randomized Comparison of Complex Coronary lesions (COBRA study) Eur Heart J:21:1759-66:2000
11. Dill T, Dietz U, Hamm C W et al: A randomized comparison of balloon angioplasty versus rotational atherectomy in complex coronary lesions: Euro intervention: 11:30-6:2015
12. Shimony A, Zahger D, Van Straten M et al: Incidence, risk factors, management and outcome of coronary artery perforation during percutaneous coronary intervention: Am J Cardiol:104:1674-1677:2009
13. Fitzerald P J, Ports T A, Yock P G: Contribution of localized calcium deposits to dissection after angioplasty: An observational study using intravascular ultrasound: Circulation 86:64:70:1992
14. Takebayashi H, Kobayashi Y, Mintz G S et al intravascular ultrasound assessment of lesions with target vessel failure after sirolimus eluting stentimplantation: Am J. cardiol:95:498-502:2005
15. Virmani r, Farb A, Burke A P: Coronary angioplasty from the prospective of atherosclerotic plaque: morphologic predictors of immediate success and restenosis: Am Heart J:127:163-179:1994
16. Hoffman R, Mintz G S, Popma J J, et al:Treatment of calcified coronary lesions with Palmatz Schatz stents: An intravascular ultrasound study: Eur Heart J. 19:1224-31:1998
17. Moussa I, Di Mario C, Moses J et al: Coronary stenting after rotational atherectomy in calcified and complex lesions; Angiography and clinical follow up results: circulation 96:128-136:1997

18. Moses J W, Leon MB, Popma J L et al: Sirolimus eluting stents versus standard stents in patients with stenosis in a native coronary artery: N.Eng J. Med:349:1315-23:2003

19. Stone G W, Ellis S G, Cox D A et al: A polymer-based paclitaxel eluting stent in patient with coronary artery disease. N. eng.J.Med 350:221-31:2004

20. Furuchi S, Sargiorgi G M, Godinoc. Et al: Rotational atherectomy followed by drug eluting stent implantation in calcified coronary lesions: Euro intervention: 5:370-374:2009

21. Abdel-Wahab M, Baev R, Dieker P et al: Long term clinical outcome of rotational atherectomy followed by drug eluting stent implantation in complex coronary lesions: Catheter Cardiovasc. Interv: 81:285-291:2013

22. Abdel-Wahab M, Richardt G, Joachim Buttner H et al: High speed rotational atherectomy before paclitaxel eluting stent implantation in calcified complex coronary lesions: the randomized ROTAXUS trial: JACC Cardiovasc Interv 6:10-19:2013

23. Barbato E, Carrie D, Dardas P et al: European Expert consensus on rotational atherectomy: Euro intervention:11:30-36:2015

24. Vaquerizo B, Serra A, Miranda F et al: Aggressive plaque modification with RA and/or cutting balloon before DES implantation for the treatment of calcified coronary lesions: J of Interventional Cardiology: Vol-23, Issue 3:240-248:2010

25. Whitlow PL, Bass TA, Kipperman RM: Results of the study to determine Rotablator & transluminal angioplasty strategy (STRATAS): Am J. Cardiol:87:699-705:2001

26. Safian R D, Feldman T, Muller D W et al: Coronary angioplasty & Rotablator atherectomy trial (CARAT): Immediate & late restenosis of a prospective multicenter randomized trial: Catheter cardiovasc Interv. 53:213-220:2001

27. Sakakura K, Funayama H, Taniguchi Y et al: The incidence of slow flow after rotational atherectomy of calcified coronary arteries: A randomized study between low speed & high speed- Catheter cardiovasc Interv: 89:832-40:2017

28. Honey I.M, Kinm S. Annapoorna, Sharma S k current status of Rotational atherectomy: JACC:Cardiovasc. Interv: 7:4345-353:2014

29. Sharma SK, Tone III, Thierstein P.S et al: North American Expert Review of Rotational Atherectomy: cir. Cardiovasc. Interv:12: e007448:2019

30. Shuvanan Ray, Siddhartha Bandyopadhyay, Prithwiraj Bhattacharjee et al: Percutaneous coronary interventions of severely/moderately calcified coronary lesions using single burr rotational atherectomy: A retrospective study: Anatol.J.Cardiol.