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Percutaneous coronary intervention after return of spontaneous circulation following in-hospital cardiac arrest with evidence of acute myocardial infarction & its neurological outcome

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ABSTRACT

Objectives: Acute myocardial infarction (AMI) is a major cause of cardiac arrest. Immediate coronary angiography and percutaneous coronary intervention (PCI) may be considered in patients who have been successfully resuscitated after cardiac arrest with pre or post-cardiac arrest documentary evidence of AMI. This study aimed to evaluate the effects of PCI on in-hospital mortality and neurological outcomes after gaining return of spontaneous circulation (ROSC) following cardiac arrest due to AMI.

Material and Methods: In this prospective observational cohort study, we randomly assigned 36 patients from August 2021 to November 2023 who had a cardiac arrest either at emergency or in patient department during ongoing care with evidence of AMI. We treated all patients with coronary intervention and supportive care including inpatient care and outpatient follow-up in 30 and 90 days to evaluate neurological outcomes.

Results: All 36 patients underwent immediate coronary angiogram (CAG) after ROSC followed by newer generation drug eluting stent (DES) implantation. The mean age of the patients was 55.39±10.89 years. Among them male was 32(88.88%), female was 4(11.11%). Smoking (77.78%) was the most common risk factor followed by diabetes mellitus (72.2%), hypertension (66.7%), dyslipidemia (55.6%), positive family history of ischemic heart disease (IHD) (38.9%), and chronic kidney disease (38.9%) patients. Among all patients, 22(61.1%) patients had acute st-segment elevated myocardial infarction (STEMI) (anterior). Ten (27.8%) patients had acute STEMI (inferior), and four (11.1%) had acute non-st-segment elevated myocardial infarction (NSTEMI). Single vessel coronary artery disease (SVD) was found in 22 (61.1%) patients, Double Vessel Coronary Artery Disease (DVD) in 8 (22.2%) patients, and triple vessel coronary artery disease (TVD) in 6 (16.7%) patients. Thirty-two patients got target vessel revascularization and four patients got total revascularization. Cardiac arrest hospital prognosis (CAHP) Score was done in all cases. Based on the score only a low (≤150) score was selected. Based on the cerebral performance category (CPC), three (8.3%) patients developed CPC-5 and died. Among the survivals pre-discharge CPC-1 was 30(83.3), CPC-2 was 01(2.8), and CPC-3 was 2 (5.5). Patient with CPC-2 was improved without any neurological deficit on 30 days follow-up. Among the CPC-3 patients, one patient died and another patient persists with mild neurological deficit. The survival and neurological outcomes were statistically significant ($p<0.05$).

Conclusion: The patients who gained ROSC after cardiac arrest caused by AMI and underwent PCI had lower in-hospital mortality and satisfactory neurological outcomes.

Keywords: Acute myocardial infarction, Cardiac arrest, Neurological outcome, Percutaneous coronary intervention, Return of spontaneous circulation

INTRODUCTION

Cardiac arrest (CA) is characterized by the abrupt cessation of the cardiac function, typically leading to unconsciousness and the absence of a pulse. This condition signifies a sudden halt

in the heart's ability to circulate blood effectively.[1] Although many efforts have been made to prevent CA, it is still the leading cause of mortality worldwide.[2] Acute myocardial infarction (AMI) is a common cause of CA which necessitates prompt evaluation & intervention such as percutaneous coronary intervention (PCI) to restore coronary blood flow. Factors associated with better survival include the time to return of spontaneous circulation (ROSC), previous comorbidities, immediate invasive coronary angiography, and/or percutaneous intervention. In this study, we will see how immediate PCI plays a significant role in terms of patient outcomes following CA. The majority of in-hospital cardiac arrest (IHCA) survivors have good neurological outcomes, with approximately 70% having a favorable outcome.[3] Despite the prevalence of IHCA secondary to AMI, widespread adoption of PCI as a treatment modality is not seen in Bangladesh leading to a paucity of comprehensive studies investigating the long-term outcomes, particularly survival rates and neurological status. Understanding the prognostic factors and outcomes associated with this specific cohort of patients is crucial for optimizing treatment strategies and improving patient care.

MATERIAL AND METHODS

We selected 36 IHCA patients with AMI who underwent PCI at Sheikh Fazilatunnessa Mujib Memorial KPJ Specialized Hospital from August 2021 to November 2023. We collected and analyzed demographic, clinical, and procedural data, risk factors, and outcomes including survival rates and neurological status assessed by standardized scales (e.g. GCS, Motor/Sensory function, cognitive function, and Gait) to measure cerebral performance category (CPC). All patients had a computed tomography (CT) scan/magnetic resonance imaging (MRI) of the brain during their hospital stay or before discharge revealing no abnormalities. A good neurological outcome was expressed as CPC-1 and CPC-2, as previously used in CA studies.[4] All outcomes were assessed during discharge, 30- and 90-day follow-up. We only include patients who gained consciousness following ROSC, Comatose patients were excluded due to its relevance with other supportive care factors. In all cases, AMI was confirmed by ECG and/or troponin-i, immediate CAG was attempted and coronary perfusion was established by PCI. This study shows a good neurological outcome and survival rate (91.67%) following coronary intervention which substantiates the effectiveness of immediate PCI in CA patients and outweighs the risk of hypoxic brain injury following ROSC.

RESULTS

The mean age of the patients was *55.39±10.89* years. Among them male was 32 (88.88%), female was 4 (11.11%). Smoking (77.78%) was the most common risk factor followed by diabetes mellitus (72.2%), hypertension (66.7%), dyslipidemia (55.6%), positive family history of ischemic heart disease. (38.9%), chronic kidney disease (38.9%), and bronchial asthma (33.9%) patients. Among all patients, 22(61.1%) patients had acute STEMI (anterior). 10(27.8%) patients had acute st-segment elevated myocardial infarction (STEMI) (inferior) & 4 (11.1%) had acute non-st-segment elevated myocardial infarction. Single vessel disease was found in 22(61.1%) patients, DVD in 08(22.2%) patients, and triple vessel disease in 6(16.7%) patients [Table 1]. All 36 patients underwent immediate coronary angiogram (CAG) after ROSC followed by newer generation drug eluting stent implantation. Thirty-two patients got target vessel revascularization and four patients got total revascularization. In all patients, a CT or MRI of brain was done as per advice of neurologist.

Cardiac arrest hospital prognosis score was done in all cases. Based on the score only low (≤150) score was selected. Based on the CPC three (8.3%) patients developed CPC-5 and died. Among the survivals pre-discharge CPC-1 was 30(83.3), CPC-2 was 01(2.8), and CPC-3 was 2 (5.5). Patient with CPC-2 was improved without any neurological deficit on 30-day follow-up. Among the CPC-3 patients, one patient died and another patient persists with mild neurological deficit [Table 2].

Table 1: Baseline characteristics of patients

Variables		Number n (%)
Age	Above 55 years	17 (47.22)
	Below 55 years	19 (52.78)
Sex	Male	32 (88.88)
	Female	4 (11.11)
Risk factors/ comorbidities	Smoking	28 (77.78)
	Diabetes	26 (72.2)
	Hypertension	24 (66.7)
	Dyslipidemia	20 (55.6)
	Kidney disease	14 (38.9)
	Family H/O IHD	14 (38.9)
	Bronchial Asthma	12 (33.9)
Wall involvement	Anterior wall STEMI	22 (61.1)
	Inferior wall STEMI	10 (27.8)
	NSTEMI	04 (11.1)
Coronary vessel involvement	SVD	22 (61.1)
	DVD	8 (22.2)
	TVD	6 (16.7)

STEMI: ST-segment elevated myocardial infarction; NSTEMI: Non-ST-segment elevated myocardial infarction; SVD: Single vessel disease; DVD: Double vessel disease, TVD: Triple vessel disease, H/O IHD: History of ischemic heart disease.

Table 2: Neurological outcome

	Assessment tool	Number of patients n (%)
In-hospital or discharge outcome	CPC-1	30 (83.3)
	CPC-2	01 (2.8)
	CPC-3	2 (5.5)
	CPC-4	0
	CPC-5/death	3 (8.3)
30 days outcome	Satisfactory	31
	Mild disability	1
	Significant disability/death	1 (Death)
90 days outcome	Satisfactory	31
	Mild disability	1
	Significant disability/death	0

CPC: Cerebral performance categories.

Table 3: Assessment (outcome) in-hospital survival

Variables		Number n (%)	p-value
In-hospital outcome	Discharge survival	33 (91.67)	0.001s
	Post procedure mortality	03 (8.3)	
	Neurological deficit	02 (5.5)	0.007s
	No neurological deficit	31 (86.1)	

s: significant.

The in-hospital survival was statistically significant after PCI ($p<0.05$). The neurological outcome is survived patients who were also statistically significant ($p<0.05$) [Table 3].

DISCUSSION

The decision to perform PCI following CA was based on the findings (e.g. ECG and Troponin-i) that were suggestive of AMI. Furthermore, Redfors *et al*. found that approximately 40% of patients without ST-segment elevation after CA and resuscitation had acute coronary artery occlusion.[5] Although the majority of cases are of cardiac origin, the decision to perform early PCI is challenging due to the lack of randomized trials and the uncertainty of the neurological outcome.[6] However, the result of this study is very promising, survival rate 91.66% at discharge without any significant neurological disability at 30- and 90-day follow-up. A recent review article included 19 studies between 1997 and 2010, reporting on adult survivors of CA who underwent PCI, The survival at discharge varied from 38% to 80%, with 34% to 71% of patients having good neurological outcomes.[6] In terms of mortality, Zhang J *et al* have shown that the in-hospital mortality in the patients who did not undergo PCI was significantly higher than that in the patients who underwent PCI (68.9% vs 9.5%, $P<0.05$).[1] This also supports the importance of early PCI in patients who survived CA and the cardiac cause is the first suspicion. The main goal was to establish reperfusion to the cardiac muscle to avoid major adverse cardiovascular events and ensure good neurological outcomes. Multiple factors influence the chance of survival, and some of the most crucial aspects have been summarized in the concept of the chain of survival: early recognition and call for help, early and efficient cardiopulmonary resuscitation, swift defibrillation, and effective post-resuscitation care.[7] However, establishing perfusion of the cardiac muscle immediately will be an added benefit which is shown in this study.

In terms of neurological outcomes, 100% of patients showed favorable neurological outcomes (CPC1 & CPC2) at discharge and 30- and 90-day follow-up. Despite a huge dilemma over performing/not performing PCI in Cardiac Arrest Survivors, most of the researchers believe that waiting for a good neurological response can be devastating and will increase the risk of continuous myocardial hypoperfusion which in turn causes more myocardial damage. Most of the authors stress giving serious consideration to primary PCI, regardless of initial neurological status for long-term benefit. For example, Keelan *et al* observed in their study that the majority of patients who were unresponsive on admission recovered fully at follow-up (CPC-1–CPC-2).[8] Lettieri *et al* reported that from the 77 patients who were discharged alive, 67 had recovered fully at follow-up.[9] Hosmane *et al* also reported that from the 59 patients who were unresponsive on admission, 44% survived with 88% having full neurological recovery.[10] Therefore, priority should be given to early CAG and PCI in CA patients in the absence of non-cardiac causes rather than waiting too long to get any evidence of AMI. However, only PCI cannot bring good outcomes in isolation, following standardized guidelines like ACLS and ALS is always recommended to achieve maximum outcomes. Not maintaining/skipping steps during the management of CA can have a significant impact on survival and neurological outcomes. A recent study has shown adherence to guidelines increased the probability of survival at 30 days and neurological function among all patients, regardless of initial rhythm.[11] Treating the underlying causes is inevitable once patients achieve ROSC irrespective of their neurological status. Here CAG and PCI should be our first priority once non-cardiac causes are excluded.

Study limitations

The present study was limited by its observational character. Moreover, it was not compared with other groups of patients who didn't undergo PCI or received other modalities of

treatment or with mechanical circulatory supports. The study population was selected from a single hospital and small sample size prevents us from drawing any firm conclusions regarding clinical outcomes. Neurological outcome data on low cerebral perfusion times couldn't be collected due to lack of resources.

CONCLUSION

The patients who gained ROSC after CA caused by AMI and underwent PCI had lower in-hospital mortality and satisfactory neurological outcomes.

Authors' contributions

MM: Moniruzzaman-Data collection, analysis, article review & manuscript writing; KSA: Analysis & review; MNH: Data collection & manuscript review; MSI and MAR: Analysis & review, guide manuscript writing.

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