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Clinical paper

Association of emergent and elective percutaneous coronary intervention with neurological outcome and survival after out-of-hospital cardiac arrest in patients with and without a history of heart disease☆

Min Jung Kim[a], Young Sun Ro[a,*], Sang Do Shin[b], Kyoung Jun Song[b], Ki Ok Ahn[a], Sung Ok Hong[c], Young Taek Kim[c]

[a] Laboratory of Emergency Medical Services, Seoul National University Hospital Biomedical Research Institute, 101 Daehak-Ro, Jongno-Gu, Seoul 110-744, Republic of Korea
[b] Department of Emergency Medicine, Seoul National University College of Medicine, Seoul, Republic of Korea
[c] Korea Centers for Disease Control and Prevention, Chungbuk, Republic of Korea

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ABSTRACT

Background: It is unclear whether the benefits of post-resuscitative percutaneous coronary intervention (PCI) are equally observed across out-of-hospital cardiac arrests (OHCAs) with different clinical presentations. The purpose of this study was to assess the effect of PCI in outcomes of OHCA and to compare patient prognosis by history of heart disease (HD) and presentations of nonshockable vs. shockable arrest rhythm by electrocardiogram (ECG).

Methods: A population-based observational study was conducted on OHCAs of cardiac etiology in Korea who survived to admission between 2009 and 2013. Multivariable logistic regression analyses were conducted to assess the associations between PCI and outcomes (favorable neurological outcome and survival-to-discharge) and to test the interaction effects of PCI with history of HD and with presence of shockable rhythm.

Results: A total of 9762 OHCAs were analyzed. PCI was done in 1140 (11.7%), and neurological recovery were observed in 45.7% of the PCI group and 13.3% of the untreated group. Effects of PCI on neurological recovery were observed similarly in patients with and without history of HD (OR = 2.33 (1.62–3.35) and OR = 2.37 (1.95–2.89), respectively). PCI was associated with survival-to-discharge only in patients without history of HD (OR = 1.80 (1.51–2.15)). PCI was associated with neurological recovery and survival-to-discharge in both shockable and nonshockable rhythms, although the estimates were relatively higher in those with nonshockable rhythms (OR for neurological recovery = 2.60 (2.04–3.32); and OR for survival = 1.78 (1.46–2.17)).

Conclusions: This study corroborates that PCI is an advantageous treatment option for all patients with OHCA regardless of established diagnosis with HD and presentations of shockable rhythm.

Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death globally. The survival rate of OHCA averages around 8%, and neurological outcome after survival is often impaired.[1] The poor prognosis of cardiac arrest is largely attributable to increased susceptibility to hypoxia and ischemic damage after arrest, which in turn produce abrupt biochemical damages in brain and myocardium.[2,3] With the primary aim of decreasing myocardial ischemia, reperfusion therapy can also reduce ventricular arrhythmia and electrical instability of the heart.[4–6] The American Heart Association recommends systematic use of reperfusion therapy, such as percutaneous coronary intervention (PCI), for ST-segment elevation myocardial infarction (STEMI) and highly suspected acute coronary syndromes.[7] In absence of ST-segment elevation, post-resuscitative echocardiography, past medical history such as heart

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* Corresponding author. Fax: +82 2 741 7855.
E-mail addresses: minkim229@gmail.com (M.J. Kim), Ro.youngsun@gmail.com (Y.S. Ro), shinsangdo@medimail.co.kr (S.D. Shin), skciva@gmail.com (K.J. Song), arendt75@gmail.com (K.O. Ahn), soh822@hanmail.net (S.O. Hong), ruyoung@cdc.go.kr (Y.T. Kim).

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disease (HD), symptoms before arrest, and initial electrocardiogram (ECG) may be used for the decision of reperfusion therapy.[8]

Manifestations of HD, such as coronary artery disease, arrhythmia, and structural abnormalities, are known risk factors of cardiac arrest due to adverse complications including thrombosis or coronary occlusion.[4,9–11] However, in earlier studies of cardiac arrest with HD, the observed effects of reperfusion therapy were somewhat controversial. In OHCA patients with STEMI, PCI was shown to reduce mortality[12–14] whilst other studies showed no evidence of early PCI linked with better neurological recovery[15] nor long-term survival.[16] In clinical routine, it is unclear whether PCI is an effective tool for alleviating ischemic injury after cardiac arrest in patients with HD, and if there are any complications arising from reperfusion injury in presence of underlying HD.[17,18]

Increasing clinical evidence recommends the application of reperfusion therapy in a broad spectrum of patients with cardiac arrest. However, studies on the effects of PCI after OHCA in conjunction with HD and initial ECG are limited. Thus, the objective of this study was to assess the effects of PCI in OHCA patients and to compare the findings by history of HD and shockable arrest rhythms by initial ECG.

Methods

This study was approved by the institutional review board of the Seoul National University Hospital, and informed consent was waived.

Study design and data source

This is a population-based observational study using the national OHCA database of Korea. The national OHCA database, which captures all incident cases of OHCA in the country, was first initiated in 2006 using emergency medical services (EMS) run sheet for basic ambulance operation information, EMS cardiac arrest registry for Utstein factors, and the national OHCA registry for hospital care and survival outcomes via hospital medical record review. EMS run sheet and EMS cardiac arrest registry were abstracted from the EMS database of the National Emergency Management Agency (NEMA). A subsequent medical record review was done using the medical records of each destination hospital by trained medical record reviewers of the Korea Center for Disease Control and Prevention (CDC). For quality assurance, monthly meetings were held by the Korea CDC Data Quality Control (DQC) team which consisted of emergency physicians, epidemiologist, statistical experts, representatives from NEMA, and medical record review experts. The DQC team provided consultation and feedback to the medical record reviewers as needed.

Study setting

In Korea, a national EMS system is operated by the national fire department and 16 provincial headquarters. Ambulances are operated by emergency medical technicians (EMTs) who are directed not to stop CPR or declare death in field or during transport, and all EMS-assessed patients are therefore transported to the nearest emergency department (ED). All EDs are designated by the government as levels 1 through 3 based on capacity and resource measures including staffing, equipment, and size of the department. Level 1 ($n = 20$) and 2 EDs ($n = 110$) are staffed by emergency physicians 24 h a day and provide the highest level of emergency care services in the country. Level 1 ED is equipped with 20 intensive care unit (ICU) beds which are specialized for emergency patients only. Level 2 EDs have general ICU beds which are shared with other departments. Level 3 EDs ($n = 310$) are staffed by general physicians and provide basic emergency care. All EDs are evaluated annually for their functional performance and fulfillment of structural requirements. All EDs generally perform acute cardiac care and resuscitation in accordance to the international standard guidelines, and physicians are responsible for making decisions for care.[19,20]

Study subjects

This study included all EMS-assessed patients with OHCAs of presumed cardiac etiology who were 19 years of age or older on the day of incident and survived to admission at hospitals between January 2009 and December 2013. Patients who had unknown neurological status at hospital discharge were excluded.

Main outcome

The primary outcome was favorable neurological outcome at discharge defined as cerebral performance category (CPC) score of 1 (conscious; able to work) or 2 (conscious; able to perform daily activities independently). The secondary outcome was survival to discharge. Both outcome measures were recorded by medical record reviewers based on hospital records drafted by physicians in charge. For ambiguous cases, the DQC team provided consultation to the medical record reviewers.

Main exposure and variables

The primary predictor, success of PCI, was collected via review of hospital medical records. For this study, success of PCI was defined as ballooning or stent insertion in coronary arteries. The term PCI disregarded the differences in starting time and duration of the intervention and did not distinguish between emergent and elective PCI.

The following variables were also collected: age, gender, past medical history (HD, hypertension, diabetes mellitus, and stroke), year of arrest, initial ECG rhythm (shockable or nonshockable arrest rhythms), residency in metropolitan area (defined as living in a city with over a million people), location of arrest (public, private, or other), witnessed status, bystander cardiopulmonary resuscitation (CPR), EMS response time interval, scene time interval, transport time interval, EMS defibrillation, ED level (levels 1, 2 and 3), therapeutic hypothermia, and prehospital return of spontaneous circulation (ROSC). For cases reported in the year 2013 only, our database captured an additional variable which records the time at which PCI was first conducted. This variable was used to estimate the time duration from ROSC to start of PCI (ROSC-to-PCI time), and ultimately to distinguish between patients who underwent early PCI and those who had late PCI after ROSC. For patients who had prehospital ROSC, time of arrival at ED was used instead of ROSC time for the calculation of ROSC-to-PCI time.

Past medical history of patients were collected by review of hospital medical records. History of HD, hypertension, diabetes mellitus, and stroke were treated as dichotomous variables. Specifically, patients were identified as having HD if they had clinical history of any of the following diseases: ischemic coronary disease including myocardial infarction (MI) and angina pectoris, valvular disease, arrhythmia, congestive heart failure, and cardiomyopathy. Cardiac rhythm was classified according to the initial ECG recorded by the EMT at the scene and were categorized as shockable (ventricular fibrillation or tachycardia) or nonshockable (pulseless electric activity and asystole) rhythm.

Statistical analysis

Descriptive statistics of all demographic, community, EMS, and clinical characteristics and outcome measures were analyzed for