Subarachnoid Hemorrhage after Resuscitation from Out-of-hospital Cardiac Arrest

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Background: This study was undertaken to retrospectively investigate clinical features of subarachnoid hemorrhage (SAH) with cardiopulmonary arrest in patients achieving return of spontaneous circulation (ROSC) in order to explore the possibility of long-term survival. *Methods:* Of 143 SAH patients with cardiopulmonary arrest in our hospital between April 2004 and June 2012, data on 59 (41%) patients who attained ROSC were analyzed to determine the predictive factors for neurologic recovery and outcome. Recovery of brainstem reflexes and improvement of Glasgow Coma Scale (GCS) motor score were noted (postresuscitation neurologic restorative assessment, grade I) in 5, and 2 of these patients survived. *Results:* By-grade analysis of patient background characteristics revealed a significantly shorter duration of cardiac arrest ($P = .001$) and a significantly smaller adrenaline dose ($P = .011$) for grade I patients. A logistic analysis of 1-week survival data revealed significant differences in duration of cardiac arrest ($P = .022$) and adrenaline dose ($P = .019$), with odds ratios of 0.89 and 0.25, respectively. Cox regression analysis of mortality data revealed significant differences in the duration of cardiac arrest ($P = .012$), adrenaline dose ($P < .0001$), and location of ROSC ($P = .016$), with hazard ratios of 1.03, 1.43, and 1.98, respectively. *Conclusions:* Cardiac arrest caused by SAH is a disease state with a grave prognosis, but there is the possibility of a good survival outcome when the administration of a small dose of adrenaline results in the rapid recovery of brainstem reflexes. **Key Words:** Post–cardiac arrest syndrome—return of spontaneous circulation—witness—return of spontaneous circulation.

In recent years, the pathogenesis of brain damage after cardiac arrest has been defined as post–cardiac arrest syndrome in the field of brain-oriented neurologic intensive care. The clinical usefulness of hypothermia for cardiogenic cardiac arrest has been confirmed by a high evidence level of increased social rehabilitation.[1] On the other hand, subarachnoid hemorrhage (SAH) is a well-known cause of cardiac arrest in patients with central nervous system disorders. Because out-of-hospital cardiac arrest caused by subarachnoid hemorrhage (OHCA-SAH) is associated with extremely low long-term survival and poor outcomes,[2,3] this disorder is often not aggressively treated. In recent years, however, sporadic cases of OHCA-SAH patients who recovered free of neurologic deficits with successful resuscitation have been reported.[4,5] It has since become clear that an extremely small number of patients with OHCA-SAH have good outcomes. Therefore, the clinical data on active treatment for OHCA-SAH need to be analyzed to recognize the limitations of medical treatment and to clarify the indications and exclusion criteria from the viewpoint of medical futility. In this study, we retrospectively analyzed patients with OHCA-SAH in our institution in terms of pathogenesis, diagnosis, treatment, and outcome, and we considered the potential indications for medical treatment of OHCA-SAH.

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Methods

Of 1842 patients with endogenous OHCA transported to our hospital between January 2004 and June 2012, 143 patients had OHCA-SAH, and 59 (41%) patients achieved return of spontaneous circulation (ROSC). We reviewed these 59 cases retrospectively. Of these 59 patients, 25 were men and 34 were women, with a mean age of 62.9 years (range 39-91 years). Cardiac arrest occurred at home in 34 cases (58%), in a public space in 9 cases (15%), in an ambulance in 6 cases (10%), and in unknown locations in 10 cases (17%). Cardiac arrest was witnessed for 36 patients (61.0%), 30 by a bystander and 6 by emergency medical services (EMS) personnel. Twenty patients received cardiopulmonary resuscitation from a bystander. ROSC occurred in an ambulance in 36 cases and at the hospital in 23 cases. The mean duration of cardiac arrest was 31.1 minutes according to the reports of EMS personnel. When the onset was witnessed, the duration of cardiac arrest was considered to be the time from assessment until ROSC. When cardiac arrest occurred ≥2 times, the duration of cardiac arrest was considered to be the sum of all times. When there was no witness, the duration of cardiac arrest was considered to be either the time elapsed from the estimated cardiac arrest until ROSC or the time from the initial emergency report until ROSC. The first recorded electrocardiogram (ECG) by EMS personnel could be reviewed in 58 patients. Asystole was documented in 26 cases, pulseless electrical activity (PEA) in 31, and ventricular fibrillation (VF) in 1. In 1 PEA case, the ECG was moving toward VF in the ambulance. Algorithms for cardiac arrest resuscitation were applied according to basic life support guidelines by EMS personnel or bystanders, and advanced cardiac life support by ≥2 health care workers. Hemodynamic stability was attempted by administering catecholamines, postresuscitation, for circulatory failure, using systolic blood pressure >90 mm Hg as the index. Assessment of neurologic recovery was evaluated based on spontaneous respiration, findings of pupils (e.g., miosis and light reflex), gag and cough reflexes, and Glasgow Coma Scale (GCS) motor scores. The postresuscitation neurologic restorative assessment (PRNRA) was classified into the following 2 grades: Grade I—recovery of brainstem reflexes (e.g., light, cough, and gag reflexes) and GCS motor subscores (>2); and Grade II—recovery of spontaneous respiration only or no recovery.

SAH was diagnosed by computed tomography (CT) in 50 cases, by cerebrospinal fluid puncture in 8 cases, and by autopsy in 1 case. After the diagnosis, an osmotic diuretic, a muscle relaxant, and sedative analgesic were administered according to brain-oriented intensive care management. Ventricular drainage and intracranial pressure (ICP) monitoring were performed in 19 cases achieving circulatory stabilization using a Camino parenchymal intracranial pressure monitoring kit (Integra LifeSciences, San Diego, CA) or Codman microsensor basic kit (Johnson and Johnson, Raynham, MA). In 11 cases achieving ROSC with normal cerebral perfusion, coil embolization was performed.

Neuroimaging findings were assessed for intraventricular hematoma (IVH) and intracerebral hematoma on CT. The degree of IVH was categorized into 2 groups: group A (none or only reflux) and group B (packing hematoma in ≥1 ventricles). Glasgow–Pittsburg cerebral performance categories (CPCs) were used for clinical outcomes after 3 months[6] as follows: CPC 1, full recovery; CPC 2, moderate disability; CPC 3, severe disability; CPC 4, comatose or in a persistent vegetative state; and CPC 5, death or brain death. Serum lactate and glucose concentrations (mg/dL) were measured at the time the patient arrived at the hospital. In this study, neurologic recovery was correlated with the following items: 1, age; 2, sex; 3, witness of cardiac arrest; 4, location of ROSC; 5, duration of cardiac arrest (min); 6, first recorded ECG; 7, total adrenaline dose (mg); 8, neuroimaging; 9, serum lactate (mg/dL); 10, serum glucose (mg/dL); and 11, clinical outcome.

Statistical Analysis

Data are expressed as the means ± standard deviation. Statistical analyses were performed using the Student *t* test for comparing the 2 grades, adjusted for age, duration of cardiac arrest, adrenaline dose, serum lactate, and serum glucose. Fisher exact probability tests were then used for comparing the 2 grades, adjusted for sex, witness, location of ROSC, ECG, IVH group, intracerebral hematoma, and 1-week survival. Simple logistic regression was used for univariate analysis concerning 1-week survival. Odds ratios were obtained through these models with 95% confidence intervals (CIs). Cox regression modeling, with mortality as the dependent variable, was used to estimate the impacts of individual factors through univariate analyses. Hazard ratios were obtained through these models with 95% CIs. A multivariate analysis was attempted for all potential predictive factors associated with 1-week survival and mortality investigated in the univariate analyses. However, only 1 item (adrenaline dose) was selected by stepwise methods (model selection criterion; $\alpha = 0.10$), and multivariate analysis could not be performed. Values related to the ICP were analyzed with the Mann–Whitney *U* test. $P < .05$ was considered statistically significant.

Results

Of all 59 patients studied, the PRNRA was grade I in 5 cases and grade II in 54 cases. There were 7 patients (11.9%) who attained 1-week survival and 2 (3.4%) who survived for 1 month (Fig 1). The clinical outcomes at 3 months after onset were CPC 1 in 1 patient (1.7%),