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Clinical Study

The outcomes of early aneurysm repair in World Federation of Neurosurgical Societies grade V subarachnoid haemorrhage patients with emphasis on those presenting with a Glasgow Coma Scale score of 3

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ABSTRACT

Grade V subarachnoid haemorrhage (SAH) patients may be dichotomised into those with temporary deterioration and those with irreversible injury, and only the former have a chance of favourable outcomes by aneurysm obliteration. One method of differentiating the two conditions is to wait and observe potential recovery for 12–48 hours. However, early rebleeding and non-convulsive seizures may occur during this period. In our institution, grade V SAH patients receive immediate treatment (general anaesthesia induction and aneurysm obliteration within 24 hours of onset) to minimise those risks. We focused on therapeutic outcomes in SAH patients presenting with a Glasgow Coma Scale score of 3 (GCS-3). Between January 2006 and December 2013, 82 GCS-3 SAH patients were admitted, among whom 51 (62%) underwent immediate aneurysm obliteration. Their outcomes 90 days after onset were evaluated with the Glasgow Outcome Scale, with either good recovery or moderate disability regarded as favourable outcomes. Multivariate logistic regression analysis was performed to identify variables correlated with favourable outcomes. Among the 51 patients, 11 (22%) had favourable 90-day outcomes. Age (odds ratio [OR], 0.838; 95% confidence interval [CI], 0.733–0.959; $p = 0.010$) and intact pupillary light reflex (OR, 21.939; 95% CI, 1.465–328.576; $p = 0.025$) were correlated with favourable outcomes. By contrast, neither intact respiratory pattern nor isocoric pupils was correlated with favourable outcomes. The current results indicate that vigorous intervention may be worth attempting in young GCS-3 SAH patients with intact pupillary light reflex. It remains unclear, however, whether the seemingly high frequency of favourable outcomes was truly due to reduction in early rebleeding or seizures.

1. Introduction

The outcomes of grade V subarachnoid haemorrhage (SAH) patients are mostly poor, because of the severe brain injury inflicted at the time of aneurysmal bleeding [1–3]. Variability in the severity of brain injury exists among grade V SAH patients: the Glasgow Coma Scale (GCS) score seems to be a reliable indicator of injury severity [4], and it is intuitively understood that the lower the initial GCS score of SAH patients, the worse their outcomes [5–7]. However, outcome prediction in grade V SAH patients may not always be feasible or reliable, because patients presenting with a GCS score of 3 (GCS-3), the lowest score on the scale, can occasionally have favourable outcomes. In our institution, grade V SAH patients undergo general anaesthesia shortly after arrival in the emergency department (ED) followed by early (<24 hours of onset) intervention to obliterate the ruptured aneurysm. We have particularly been interested in the outcomes of SAH patients presenting with a GCS score of 3 (GCS-3 SAH) who underwent vigorous intervention. The outcomes of the World Federation of Neurosurgical Societies (WFNS) grade V SAH patients who underwent early aneurysm repair were summarised [8], and we attempted to establish whether outcome prediction by clinical and radiographic variables at the time of admission might be possible.

2. Materials and methods

2.1. Patients

This was a single-centre retrospective study. The study design was approved by our institutional internal review board, and informed consent was obtained from patients' surrogates. Since

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2000, it has been our institutional policy that grade V SAH patients receive immediate treatment to obliterate the ruptured aneurysm. Exceptions to the aforementioned policy are as follows: patients of >80 years of age, those with prolonged/unwitnessed cardiac arrest, those with bilaterally fixed and dilated pupils after initial resuscitation, those with intractable hypotension unresponsive to vasopressors, those with advanced malignancy, those with radiographic evidences of irreversible brain injury such as loss of gray-white matter discrimination and non-filling of the cerebral vessels with contrast material, and those whose surrogates refused treatment. In-hospital electronic medical records and an institutional database from January 2006 and December 2013 were reviewed extensively to identify grade V SAH patients.

By definition, all grade V SAH patients are comatose. On the basis of the American Heart Association Advanced Cardiac Life Support Guidelines [9], they underwent initial resuscitation, including placement of intravenous lines and endotracheal intubation under general anaesthesia in ED. Propofol and rocuronium were administered via continuous intravenous (CIV) infusion as a sedative and muscle relaxant, respectively. Patients with bilaterally dilated pupils received bolus mannitol infusion unless they were severely hypotensive. Hypotensive patients, defined as those with systolic blood pressure (SBP) <100 mmHg for a prolonged period, received a CIV infusion of dopamine and/or norepinephrine. Patients with concomitant pulmonary oedema were treated with mild positive end-expiratory pressure. After being stabilised in ED, they were brought to the CT suite. If non-enhanced CT scans revealed the presence of SAH, three-dimensional CT angiography was obtained to identify the ruptured aneurysm. The ruptured aneurysms in grade V SAH patients were treated preferentially using an endovascular technique rather than clipping, unless massive intracerebral/-subdural haematoma causing midline shift was present or the aneurysmal shape was considered unfit for coiling. Maximal effort was made to obliterate the ruptured aneurysm within 24 hours of onset. In patients who underwent coiling of the aneurysm, either external ventricular drainage (EVD) or spinal drainage was placed shortly before or after the endovascular procedure to decrease intracranial pressure (ICP) and remove the subarachnoid clot. General anaesthesia was continued at least for 48 hours after aneurysmal obliteration. Postoperatively, intravenous fasudil hydrochloride (Asahikasei Pharma, Miyazaki, Japan), low molecular-weight dextran and albumin were routinely administered to prevent vasospasm. For patients with symptomatic vasospasm, triple-H therapy was initiated.

2.2. Outcomes assessment

The outcomes of grade V SAH patients who underwent early aneurysm repair were evaluated 90 days after onset using the Glasgow Outcome Scale (GOS) scoring system [8]. The evaluation, based on chart review of our institution and rehabilitation/nursing care facilities affiliated with our institution, to which most of our patients were transferred after discharge, was conducted by a neurosurgeon who had not been involved in the care of those patients. For patients who were transferred to other unaffiliated rehabilitation facilities, their family members were contacted by a telephone and after acquisition of their informed consent, were asked about the condition of the patient at 90 day after onset. The same neurosurgeon reviewed and interpreted all CT scans of patients. Favourable outcomes were defined as either good recovery (GR) or moderate disability (MD) on GOS. Clinical and radiographic variables were compared between those with favourable and unfavourable outcomes. In particular, we focused on the outcome predictability of brainstem signs observed at the time of induction of general anaesthesia: patients were dichotomised as having either isocoric or anisocoric pupils; intact or absent pupillary light reflex; and normal respiratory pattern or agonal respiration/respiratory arrest. The pupillary light reflex was evaluated with a medical penlight. All patients who developed agonal respiration or respiratory arrest during transfer or initial resuscitation in ED had undergone assisted ventilation by paramedics or ED physicians. Both the brainstem signs and respiration patterns used for analysis were those observed in ED at the time of (or immediately before) induction of general anaesthesia, and only data recorded by our ED physicians or neurosurgeons were used. Patients presenting with convulsive seizures were excluded from analysis.

2.3. Statistical analysis

A chi-squared test and Student's t-test were used for comparison of categorical and numerical variables, respectively. Multivariate logistic regression analysis to identify clinical/radiographic variables that correlated with favourable outcomes was performed using JMP software (SAS Institute, Cary, NC, USA). Numerical data are expressed as mean ± SD, and p value of <0.05 was considered statistically significant.

3. Results

3.1. Demographics

Between January 2006 and December 2013, a total of 82 SAH patients whose GCS score was 3 at the time of ED arrival were identified. Thirty-one patients did not undergo treatment for the ruptured aneurysm either because of presence of radiographic evidence of irreversible brain injury (n = 15), their poor systemic condition (n = 8), or because of lack of consent from their surrogates (n = 8). The remaining 51 patients underwent early treatment to repair the ruptured aneurysm. They consisted of 24 men and 27 women (mean age: 58.3 ± 13.9 years). The locations of the ruptured aneurysm in order of frequency were: anterior communicating artery/anterior cerebral artery (ACA) in 17, middle cerebral artery (MCA) in 13, vertebral artery (VA) in 10, internal carotid artery (ICA) in nine, and basilar artery (BA) in two patients. Among the 10 patients with VA aneurysms, seven harboured a dissection of VA. Twenty-six patients underwent coiling and the other 25 patients underwent clipping for the ruptured aneurysm. All 26 patients treated by coiling underwent EVD/spinal drainage placement shortly before or after coiling. All 26 patients that underwent coiling had successful aneurysmal obliteration without intra/postoperative rebleeding. In one of the 25 patients who underwent surgery, aneurysmal clipping could not be achieved because of severe brain swelling. The length of hospital stay ranged from 2 to 151 days, with a mean of 68.7 ± 38.7 days in patients who were discharged alive and of 34.2 ± 46.8 days in those who deceased during hospitalisation.

3.2. Outcomes

GOS scores at 90 days in the 51 GCS-3 SAH patients were GR in two, MD in nine, severe disability in seven, persistent vegetative state in 11, and death in 22 (Fig. 1). Eleven patients (22%) exhibited favourable outcomes at 90 days. The outcomes were evaluated by a chart review in 44 patients who had stayed in our institution or had been transferred to the affiliated facilities at 90 days, and by phone interviews with patient's family members in the other seven patients who had been transferred to other unaffiliated facilities at 90 days.