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Primary decompressive craniectomy for poor-grade middle cerebral artery aneurysms with associated intracerebral hemorrhage

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ABSTRACT

Objective: Aggressive surgery seems mandatory for poor-grade middle cerebral artery (MCA) aneurysm with associated intracerebral hemorrhage (ICH). However, primary decompressive craniectomy (DC) is controversial. We performed a case control study to define the role of primary DC.
Materials and methods: We analyzed data from the two cohorts: a multicenter prospective poor-grade aSAH registry study (AMPAS); and the National Clinical Research Center for Neurological Diseases (NCRC-ND) database of poor-grade patients. Outcome was assessed by modified Rankin Scale (mRS) and was dichotomized into favorable (mRS 0–3) and unfavorable outcome (mRS 4–6). We compared major complication rates, mortality and outcomes between primary DC and control groups.
Results: Twenty-four patients with primary DC were included in the study group. Fourteen patients without DC were included in the control group. Patients with younger age and lower Glasgow coma score (GCS) more often underwent primary DC. Major complications did not differ between the two groups. Fourteen (58%) patients had a favorable outcome, and the mortality was 29%. Primary DC appeared to have lower in-hospital mortality and have better outcome. Adjusting for age and admission GCS, primary DC was not significantly associated with decreased mortality and improved outcomes.
Conclusions: Although primary DC does not increase postoperative complication and mortality risk, current results showed primary DC does not seem to be significantly associated with improved outcomes. However, more than one half of patients most benefit from primary DC. Further prospective controlled studies are warranted to clarify the issue.

1. Introduction

Poor-grade middle cerebral artery (MCA) aneurysm with associated intracerebral hemorrhage (ICH) is associated with poor clinical condition and poor outcome [1–7]. Aggressive aneurysm clipping and hematoma evacuation seems mandatory. However, the outcome is still poor [6,8,9]. Decompressive craniectomy (DC) can reduce increased intracranial pressure and improve cerebral perfusion. It has been reported to be used in the treatment of massive ischemic stroke, severe traumatic brain injury and aneurysmal subarachnoid hemorrhage (aSAH) [10–16]. Out of these patients with aSAH, patients with associated ICH might benefit most from DC [11,16]. However, the role of primary DC for poor-grade MCA aneurysm with associated ICH is not well defined and still controversial [8,10–18].

Based on current results of DC for ischemic stroke and severe brain injury, we hypothesized primary DC could improve clinical outcomes of poor-grade MCA aneurysm with associated ICH. Therefore, we performed a multicenter retrospective case-control study to define the role of primary DC for such poor-grade patients.

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2. Material and methods

2.1. Patient cohorts

Between October 2010 and March 2012, 293 poor-grade aSAH (World Federation of Neurosurgical Societies [WFNS] grades IV and V) patients were prospectively enrolled in a multicenter prospective poor-grade aSAH registry study (AMPAS) [19]. Sixty patients (20%) with MCA aneurysms were identified. Between March 2012 and April 2014, 35 poor-grade patients with aSAH undergoing surgery in the database of China National Clinical Research Center for Neurological Diseases (NCRC-ND), and 17 patients with MCA aneurysms were identified. This study was approved by the Institutional Review Board of Beijing Tiantan Hospital, Capital Medical University.

2.2. Study population

Poor-grade patients with MCA aneurysms with associated ICH were included in the study group if they were over 18 years and less than 75 years old, presented with WFNS grade IV or V on admission, and presented with large ICH (at least 30 ml in volume). Patients were excluded if they improved to WFNS grade I–III before surgery, if they underwent aneurysm coiling, and if they performed secondary DC due to cerebral infarction or postoperative hematoma. Twenty-two consecutive patients in the AMPAS study and 2 patients in the NCRC-ND database treated with primary DC were included in the study group.

2.3. Control population

As comparison group, poor-grade patients with MCA aneurysms with associated ICH were included if they met the same inclusion criteria listed above and if they did not undergo primary or secondary DC. Four consecutive patients in the AMPAS study and 10 patients in the NCRC-ND database were included in the control group.

2.4. Clinical management

Primary DC was often performed in poor-grade MCA aneurysm with associated large ICH in the AMPAS study. All aneurysms were clipped through a frontotemporal approach. Patients with brain herniation underwent a frontotemporal parietal craniotomy. Additional temporal bone was removed down to the floor of the middle fossa, and the dura was opened widely in a stellate fashion according to a previously published protocol [10,17]. Poor-grade patients with ICH often underwent aneurysm clipping and hematoma evacuation without DC in the NCRC-ND. All ruptured aneurysms were clipped through a standard pterional approach. These patients underwent extended craniectomy only if massive intraoperative brain swelling occurred. Following surgery, all patients were transferred to the intensive care unit for postoperative therapy. They did not routinely perform interventricular intracranial pressure (ICP) monitoring.

2.5. Outcome measures

Postoperative aneurysm rebleeding, cerebral infarction, symptomatic vasospasm, hydrocephalus and pneumonia were defined as major complications during hospitalization [20,21]. All patients in the AMPAS study underwent follow-up during the first 12 months after aSAH. All patients in the NCRC-ND database were followed-up at the mean time of 14.4 months (range, 4–27 months). In this study, the mean time of follow-up was 12.8 months (range, 4–27 months). Outcome was assessed by modified Rankin Scale (mRS) and was dichotomized into favorable (mRS 0–3) and unfavorable outcome (mRS 4–6).

2.6. Statistical analysis

To compare demographic and baseline characteristics between DC and control groups, an independent-samples *t*-test was used for continuous variables, and a two-tailed Fisher's exact test was used for categorical variables. Major postoperative complications between the two groups were compared by the Fisher's exact test. Multivariate logistic regression was used to adjust for patient characteristic differences between groups. The adjusted odds ratio (OR) and 95% confidence interval (CI) were calculated. A probability value of less than 0.05 was considered statistically significant (SPSS, version 13.0; SPSS, Inc.; Chicago, Illinois).

3. Results

3.1. Patient characteristics

Twenty-four consecutive patients with primary DC were included in the study group. Fourteen consecutive patients without DC were included in the control group. Demographic and baseline characteristics are presented in Table 1. Patient characteristics did not differ between the two groups except for patient age, Glasgow coma score (GCS) on admission and at the time of surgery. Primary DC was performed more frequently in younger patients ($p = 0.019$) and patients with lower GCS on admission ($p = 0.025$) and at the time of surgery ($p = 0.005$). Eight (33%) patients in the DC group and three (20%) in the control group had brain herniation; however, there was no significant difference between the two groups ($p = 0.168$). There was also no significant difference of timing of

Table 1
Patient characteristics of primary DC and control groups.

Characteristics	DC group	Control	*p*-Value
No. (male/female)	24 (13/11)	14 (3/11)	0.088
Age, year (range)[a]	52 (29–72)	60 (46–69)	0.019
Current smoking (%)	6 (25)	2 (14)	0.684
Medical history			
Hypertension, *n* (%)	12 (50)	7 (50)	1.000
Diabetes mellitus, *n* (%)	7 (29)	3 (21)	0.715
GCS on admission, *n* (range)[a]	7 (3–12)	9 (4–12)	0.025
WFNS grade on admission			0.175
IV, *n* (%)	13 (54)	11 (79)	
V, *n* (%)	11 (46)	3 (21)	
GCS before surgery, *n* (range)[a]	7 (3–12)	9 (4–12)	0.005
WFNS grade before surgery			0.088
IV, *n* (%)	11 (46)	11 (79)	
V, *n* (%)	13 (54)	3 (21)	
Hematoma volume, ml (range)	48 (30–70)	56 (30–72)	0.168
Brian herniation, *n* (%)	8 (33)	3 (21)	0.488
Interventricular hemorrhage, *n* (%)	7 (29)	8 (57)	0.168
Aneurysm size, mm (range)	6 (2–12)	7 (3–20)	0.238
Multi-aneurysms, *n* (%)	3 (13)	3 (14)	1.000
Fisher grade			1.000
I–II	1 (4)	1 (7)	
III–IV	23 (96)	13 (93)	
Timing of surgery			0.094
<24 h, *n* (%)	16 (67)	5 (36)	
>24 h, *n* (%)	8 (33)	9 (64)	
Time of follow-up, m (range)	12 (9–22)	14 (4–27)	0.538
In-hospital mortality, *n* (%)	3 (13)	3 (21)	0.650
Discharge favorable, *n* (%)	4 (17)	3 (21)	1.000
Overall mortality, *n* (%)	7 (29)	3 (21)	0.715
Follow-up favorable, *n* (%)	14 (58)	8 (57)	1.000

DC = decompressive craniectomy; GCS = Glasgow coma score; WFNS = World Federation of Neurosurgical Societies.

[a] Indicates significant differences between the two groups ($p < 0.05$).