Outcome After Endovascular Treatment of Hunt and Hess Grade IV or V Aneurysms
Comparison of Anterior Versus Posterior Circulation

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Background and Purpose—The most common cause of poor treatment outcome in patients suffering aneurysmal subarachnoid hemorrhage is cerebral vasospasm, especially in cases of poor Hunt and Hess grades (IV and V). A further prognostic factor in surgically treated patients is aneurysm localization. The aim of the present retrospective study is to compare the endovascular treatment outcome in such poor-grade patients according to aneurysm localization in either the anterior (AC) or posterior (PC) circulation.

Methods—Forty poor-grade patients admitted between 1993 and July 1998 were treated by endovascular approach within 23 days after aneurysm rupture. Eighteen had aneurysms in the AC, 22 in the PC. Mean treatment delay was 4 days after rupture and median, 2 days. One patient showed multiple aneurysms. In 36 cases, aneurysms were occluded by Guglielmi detachable coils; in 4 cases, by parent vessel balloon occlusion.

Results—The incidence of delayed ischemic neurological dysfunction or cerebral infarct due to vasospasm did not differ significantly between the AC and PC groups. Two procedure-related complications with clinical effect were observed in each group. At 6 months’ follow-up, the result was good in 5 patients and poor in 13 in the AC group and good in 11 patients and poor in 11 in the PC group.

Conclusions—Given comparable incidence of vasospasm in poor-grade patients, a tendency toward better treatment outcome was found in patients with aneurysms in the posterior circulation ($\chi^2=2.04; P=0.15$) than in the anterior circulation. Endovascular therapy for poor-grade patients is recommended, as are further studies to determine treatment differences. (Stroke. 1999;30:2617-2622.)

Key Words: aneurysm ■ subarachnoid hemorrhage ■ endovascular therapy ■ vasospasm ■ outcome

Aneurysm surgery within 72 hours of subarachnoid hemorrhage (SAH) has proved to be a most favorable treatment. However, the introduction of acute-stage endovascular treatment and the implementation of Guglielmi detachable coils (GDC) or balloons has become a genuine alternative. Endovascular therapy results are today comparable with those achieved by surgery for aneurysms localized in the posterior circulation (PC). The treatment risks and outcome in patients with aneurysms in the anterior circulation (AC) have not been well documented until now. Poor-grade patients are often excluded from longitudinal studies. But in view of the promising treatment results that we observed through our clinical practice of the newer neuroradiological methods and to define future selection criteria for patients assumed to be treatable by endovascular therapy, we decided to analyze and compare outcomes and complication rates in poor-grade patients with aneurysms either in the AC or PC.

Subjects and Methods

Between January 1993 and July 1998, 179 patients were treated endovascularly in our center. Forty-five of these were rated as Hunt and Hess (H&H) grade IV or V on admission. (The 23 patients with H&H grade IV or V at admission that were treated by surgery [eg, mass effects] during the same period are not evaluated here.) Because some of the patients had first been admitted to other hospitals and were later transferred to our treatment center for specialized treatment, the beginning of treatment was sometimes greatly delayed. For the present retrospective evaluation (see Table 1), we also eliminated 4 patients in whom the danger of vasospasm was judged as negligible at $>23$ days after admission (Table 1). One other patient who also was eventually treated surgically could not be clearly evaluated and was not studied. Other than through these logical criteria, no attempt was made to select cases for evaluation. No aneurysm sites were excluded. Thus, case studies were performed on 40 patients graded H&H IV or V on admission among a total of 179 endovascularly treated patients admitted between January 1993 and July 1998. In 18 patients, aneurysms were found in the AC; in 22, in the PC (see Table 1). Diagnosis was reached by clinical and neurological examination and computerized tomographic (CT) scan.
### TABLE 1. Endovascular Treatment of Poor-Grade Aneurysms

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<th>Patient No.</th>
<th>Age, y</th>
<th>Gender</th>
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<th>Fisher Grade</th>
<th>Size†</th>
<th>Re-SAH</th>
<th>Time Lapse, d‡</th>
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<th>Complication</th>
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A indicates anterior circulation; P, posterior circulation; PICA, posterior inferior cerebellar angiogram.

*At admission.
†Size of aneurysm is indicated as follows: S, small (<6 mm diameter); M, medium (6–15 mm); L, large (15–25 mm); G, giant (>25 mm).
‡No. of days between first bleeding and treatment.
§Follow-up by angiography.
¶Symptomatic vasospasm was defined as cerebral infarction or DIND.
#First angiogram did not show the aneurysm.
Cerebral angiography was performed within the first 24 hours after admission. Aneurysm size was classified according to Yasargil (Table 1). A femoral treatment approach was used, and after fluoroscopic establishment of an optimal projection for GDC treatment, superselective catheterization of the aneurysm was performed by use of microcatheters. For dissecting or fusiform aneurysms, a parent vessel occlusion was chosen; 2 detachable balloons were used to ensure success. Treatments were performed with the patient under general anesthesia and 5,000 U of heparin IV. In the acute phase, the Glasgow Coma Scale was recorded every hour. CT scans were performed in each case of clinical neurological deterioration and at least every 48 hours within the first 7 days after SAH onset. Transcranial Doppler ultrasound (TCD) was performed at least every 24 to 48 hours to detect elevated flow velocities. Mean flow velocities of >130 cm/s in major vessels of the anterior cerebral circulation and intracranial extracranial velocity ratio >3 were defined as vasospasm. All such patients received intravenous nimodipine and hypertensive, hemodilution (3H) therapy that consisted of an aggressive volume expansion by means of administration of high-volume crystalloid to maintain central venous pressure between 8 and 10 mm Hg and the fluid balance in a positive range between 500 and 1000 mL/d. This, of course, was individualized in relation to hemodynamic parameters. Hematocrit was maintained at approximately 35% (between 30% and 40%) and systolic blood pressure between 160 and 180 mm Hg, sometimes by use of catecholamines. All patients were monitored by use of serial chest x-ray films to screen for pulmonary edema. 3H therapy was begun immediately after complete endovascular aneurysm occlusion and continued until normalization of mean blood flow velocities. Symptomatic vasospasm was defined as cerebral infarction or delayed ischemic neurological dysfunction (DIND). The outcome according to the Glasgow Outcome Scale was evaluated after 6 months. Follow-up angiograms were performed in 7 of the GDC treated cases after 1 year (see Table 1).

**Results**

**AC Aneurysms**

Eighteen patients with AC aneurysms were treated by endovascular therapy, 17 by GDC, and 1 by balloon technique. One patient (patient A-5) had 3 aneurysms, which were all treated at once because of a diffuse SAH (Figure 1). Thirteen patients were treated within 3 days after SAH onset; mean interval was 4 days (range 0 to 19 days). During GDC treatment, 1 aneurysm rupture (patient A-9) and 2 distal branch clots were observed (patients A-1 and A-7), which led to a complication rate of 3 of 17%.

No further procedure-related embolic infarctions were judged to have occurred during the follow-up period. In 1 patient (patient A-4) (6%), the aneurysm was intentionally occluded only 90% to avoid collateral clotting damage. A giant aneurysm in another patient (patient A-13) was intentionally closed only partially during the initial treatment and completely occluded in a second treatment session after 3 months. Elevated mean flow velocities measured by TCD were observed in 5 (28%) cases, and angiographic narrowing of the vessels (angiographic vasospasm) was seen in 5 (28%) patients. Seven (39%) patients developed DIND, and cerebral infarct due to vasospasm was diagnosed by...
CT scan in 8 (44%) patients (Table 2; see also Figure 2). Cerebral infarct or DIND (symptomatic vasospasm) were seen in 9 (50%) patients. At 6 months, the outcome was good in 5 patients but poor in 13 in the AC group (Table 3).

PC Aneurysm

Fortunately for the present evaluation, many “difficult” cases were transferred to our treatment center from other clinics, so that the disproportionately large number of 22 patients with PCs in the PC system could be treated. All 22 patients with PC aneurysms were treated by endovascular approach: 19 by GDC and 3 by balloon occlusion technique. Thirteen were treated within the first 3 days after onset of SAH, with a mean interval of 5 days (range, 0 to 23 days). One GDC patient (patient P-22) had to be retreated as a result of the coil compacting after 1 month. During the GDC treatment, 1 aneurysm rupture (patient P-1) was observed and 1 coil broke (patient P-6), without clinical effect. In 1 patient (patient P-13) with a clot, an infarct of the posterior cerebral artery occurred under GDC treatment. One balloon occlusion of a

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</table>

Figure 2. Patient A-6. Cerebral CT scan depicts signs of early cerebral ischemia induced by vasospasm (arrow) before therapy (A). After 5 days, the residual infarct is seen (B). Lateral projection of the aneurysm of the right communicating artery before (C) and after (D) occlusion by GDC.
vertebral artery was complicated by a posterior inferior cerebellar arterial infarct (patient P-3). Other than in these 4 of 22 (18%) patients, no further procedure-related complications or deficits were observed within the follow-up period. In 2 patients (patients P-8 and P-14; 9%) aneurysms were intentionally only partially occluded to avoid collateral clotting damage. A giant aneurysm in another patient (patient A-13) was intentionally only partially closed in the initial treatment and completely occluded in a second treatment session after 3 months. Elevated mean blood flow velocities were diagnosed in 12 (55%) cases by TCD and in 7 (32%) cases angiographically. Six (27%) patients developed a DIND and 8 (36%) a cerebral infarct due to vasospasm (Table 2). Cerebral infarct or DIND (symptomatic vasospasm) was seen in 8 (36%) patients. At 6 months, the outcome was good in 11 patients and poor in 11 in the PC group (Table 3).

Follow-Up

Sixteen patients (1 with balloon occlusion) died within 30 days after treatment (see cause of death in Table 1). Routine control angiographic examinations after GDC at 1 year after treatment could not always be obtained because of death (n=15), poor condition (n=6), noncompliance (n=5), or recent treatment (n=2) of the patient, so that only 8 of 36 patients were examined between 8 and 22 months (mean, 16 months) after treatment. In these patients, treatment results remained stable. Clinical follow-up examinations after balloon technique were performed after 6 months (see Table 1).

Discussion

Endovascular treatment result in poor-grade patients has not been examined until the present study. Factors generally influencing prognosis are status on admission, type and timing of therapy, complications, and aneurysm localization. The reported incidence of vasospasm in poor-grade patients varies between 1.5% and 91%, which reflects the diagnostic difficulties and the different and hardly comparable measurement methods and definitions of vasospasm. Definitions include angiographic findings of vasospasm, TCD velocity elevations, neurological deficits, and amount of cisternal blood. Some authors found a lower incidence in poor-grade patients than in patients at H&H grade I or II, in contrast with the findings of Hirai et al and Awad et al, which showed a direct correlation between initial grade and severity of vasospasm. Fisher et al, who found that vasospasm strongly correlates with the amount of cisternal blood seen in CT scans, developed a system of classification. In another study, 97% of cerebral angiograms on day 5 of SAH showed evidence of angiographic spasm. But to date, no common and definitive staging method has been created for vasospasm because of various diagnostic difficulties.

1. Neurological deteriorations such as DIND can be overlooked or misdiagnosed in unconscious and sedated patients.

2. Blood-flow velocity elevations were not seen in every vasospasm; some cases had lower velocities than expected in poor-grade patients, so TCD alone could not be used for diagnosis.

3. A high percentage of patients died before they developed vasospasm.

Thus, it is not surprising that many published clinical series exclude poor-grade patients from analysis. In their prospective series, Disney et al failed to clearly demonstrate an association between severe diffuse angiographic vasospasm and worse outcome, because many patients died from other causes or did not survive long enough to manifest the deterioration. Fisher et al showed a direct correlation between the amount of cisternal blood and severity of vasospasm. Others reported that the early surgical evacuation of cisternal blood was not able to displace vasospasm from its major role.

Endovascular techniques offer an alternative to surgery as a treatment tool for ruptured aneurysms at the acute SAH stage. Endovascular techniques prevent rebleeding and allow aggressive management of symptomatic vasospasm by 3H therapy and angioplasty. Murayama et al were able to show that the 23% incidence of symptomatic vasospasm in their endovascular series of H&H grade I through III patients hardly differs from 2 surgical series under similar clinical conditions and a symptomatic vasospasm incidence of 22% or 25%. Our 43% incidence of DIND or cerebral infarct (symptomatic vasospasm) for endovascular treatment of poor-grade patients stressing its major effect on treatment outcome.

On the basis of results of Kassell et al concerning early or late therapy for poor-grade patients, 2 studies showed identical results of 21% favorable, 37% poor outcome, and 42% death for all poor-grade patients with selective surgical agressive management. After an aggressive surgical patient management, Le Roux et al demonstrated better results of 38.5% favorable, 18% poor, and 43.5% death. Disney et al differentiated between AC and PC in their study of achieved surgical results but included patients with H&H grade III, which makes a comparison with the present report difficult. In contrast with the present report, their results showed a tendency toward poorer outcome in the hind circulation. Hillman et al achieved a 35% favorable outcome for posterior fossa aneurysms by means of delayed and early surgery. Peerless et al achieved a 27% favorable outcome with early surgery. Results of endovascular trials include only few patients. Our retrospective series with a 40% total favorable outcome is comparable with the achieved surgical results and somewhat better than previous reports on the PC.

The 18% incidence of procedure-related complications (7 patients) in our series is comparable with the 21% incidence reported in 75 patients in all H&H stages on admission with vertebrobasilar aneurysms. Fatal outcome was seen in 4 patients (10%) (Table 1) who suffered complications during endovascular therapy compared with 9% from the series with vertebrobasilar aneurysms, which indicates that poor-grade patients are not at higher risk for developing severe procedure-related complications.

In conclusion, the endovascular treatment of poor-grade patients after aneurysmal SAH is effective and offers results similar to those from surgical series. In these patients,
statistically significant differences between cases of aneu-
rysms in the PC and AC systems could not be established
(χ²=2.04; P=0.15); thus, further studies under inclusion of
larger populations could prove useful. We feel encouraged to
recommend endovascular therapy for these patients.

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