Endovascular Treatment of Aneurysmal Subarachnoid Hemorrhage in Japanese Registry of Neuroendovascular Therapy (JR-NET) 1 and 2

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Abstract

To distinguish the characteristics of ruptured cerebral aneurysm that are suitable for endovascular treatment from those that are not, we evaluated factors that influenced the results of aneurysm embolization in patients with ruptured cerebral aneurysm, based on data from the Japanese Registry of Neuroendovascular Therapy (JR-NET) 1 and 2. The multivariate analysis revealed that young patients, patients with low modified Rankin Scale (mRS) scores before onset, and patients with low World Federation of Neurosurgical Societies (WFNS) grades had good outcome. Compared to proximal internal carotid artery (ICA) aneurysms, the odds ratio of middle cerebral artery (MCA) aneurysms was 1.67, indicating poorer outcome for MCA aneurysms, and patients with small, wide-neck cerebral aneurysms had poor outcome. Patients treated after 15 days had better outcome than during other periods. The timing of treatment, however, did not influence the outcome in patients treated within 14 days. The outcome was poorer when the responsible doctor for the treatment was a specialist or a non-specialist than a supervisory doctor. The outcome of patients treated with bare platinum coils, and three dimensional (3D) rotational angiography was better, and the outcome of patients who completed treatment with body filling was poorer than in patients with complete occlusion. Perioperative hemorrhagic complications, all ischemic complications, and rebleeding occurred in 4.5%, 6.4%, and 1.4% of patients, respectively. All these complications had poor outcome factors on day 30, with odds ratios of 2.72, 2.96, and 25.49, respectively. We must be fully aware of these risk factors and determine indications for the treatment when endovascular treatment is performed as the treatment of choice for ruptured cerebral aneurysm.

Key words: endovascular treatment, aneurysmal subarachnoid hemorrhage, nationwide surveillance

Introduction

Prevention of rebleeding is critical for a successful treatment of ruptured cerebral aneurysm.1 In the Japanese Guidelines for the Management of Stroke 2009,2 surgical treatment and endovascular treatment are recommended as a Grade A recommendation to prevent rebleeding from a ruptured aneurysm. The usefulness of endovascular treatment has been reported in large studies, including the International Subarachnoid Aneurysm Trial (ISAT)3,4 and meta-analyses,5,6 and increasing numbers of Japanese institutions are using...
endovascular treatment as a first-line treatment. Under such circumstances, the most important challenge facing at present is to distinguish the types of ruptured cerebral aneurysms that are suitable for endovascular treatment from those that are not.

In the present study, the results of aneurysm embolization in patients with ruptured cerebral aneurysm were analyzed and factors that influenced the outcome for the patients were evaluated based on the database from the Japanese Registry of Neuroendovascular Therapy 1 (JR-NET1, 2005 to 2006) and 2 (JR-NET2, 2007 to 2009).

**Materials and Methods**

Of a total of 31,968 patients enrolled in JR-NET1 and JR-NET2, 5,102 patients (1,714 in JR-NET1 and 3,388 in JR-NET2) who underwent aneurysm embolization for the treatment of ruptured cerebral aneurysm, were included in the evaluation.

Table 1 lists the characteristics of patients, aneurysms, treatments, and complications. To standardize the characters of JR-NET1 and JR-NET2, classifications were modified. The sites of cerebral aneurysm were reclassified as follows: A1, Acom (anterior communicating artery), and dACA (distal internal carotid artery) were classified as ACA (anterior cerebral artery); BA (basilar artery) trunk, Basca (basilar-superior cerebellar artery), and BABif (basilar artery bifurcation) were reclassified as BA; VA (vertebral artery), or PCA (posterior cerebral artery), and others (post. circulation) were reclassified as aneurysms in the posterior fossa other than BA, VA, and PCA. Internal carotid aneurysms were

| Table 1 Characteristics of patients, aneurysms, treatments, and complications |
|--------------------------------|-----------------|-----------------|-----------------|
|                                | JR-NET1 (n = 1,714) | JR-NET2 (n = 3,388) | Total (n = 5,102) |
| Age                           | 64.12 ± 14.08    | 64.50 ± 14.56    | 64.37 ± 14.40    |
| Sex                           | Female 1,212 70.7% | 2,387 70.5%     | 3,599 70.5%      |
|                               | Male 502 29.3%   | 1,001 29.5%     | 1,503 29.5%      |
| mRS before onset              | 1,194 69.7%      | 2,394 70.7%     | 3,588 70.3%      |
| 0                             | 119 6.9%         | 287 8.5%        | 406 8.0%         |
| 1                             | 98 5.7%          | 199 5.9%        | 297 5.8%         |
| 2                             | 95 5.5%          | 143 4.2%        | 238 4.7%         |
| 3                             | 79 4.6%          | 147 4.3%        | 226 4.4%         |
| 4                             | 92 5.4%          | 145 4.3%        | 237 4.6%         |
| 5                             | 37 2.2%          | 73 2.2%         | 110 2.2%         |
| Unknown                       | 343 20.0%        | 596 17.6%       | 939 18.4%        |
| WFNS classification           | 521 30.4%        | 905 26.7%       | 1,426 27.9%      |
| 2                             | 274 16.0%        | 566 16.7%       | 840 16.5%        |
| 3                             | 313 18.3%        | 681 20.1%       | 994 19.5%        |
| 5                             | 239 13.9%        | 483 14.3%       | 722 14.2%        |
| Unknown                       | 24 1.4%          | 157 4.6%        | 181 3.5%         |
| Site                          | 521 30.4%        | 1,033 30.5%     | 1,554 30.5%      |
| ACA                           | 436 25.4%        | 838 24.7%       | 1,274 25.0%      |
| Pcom                          | 63 3.7%          | 158 4.7%        | 221 4.3%         |
| Distal ICA                    | 95 5.5%          | 182 5.4%        | 277 5.4%         |
| Proximal ICA                  | 110 6.4%         | 210 6.2%        | 320 6.3%         |
| MCA                           | 289 16.9%        | 570 16.8%       | 859 16.8%        |
| VA, PCA                       | 178 10.4%        | 300 8.9%        | 478 9.4%         |
| Unknown                       | 22 1.3%          | 97 2.9%         | 119 2.3%         |
| Size                          | 127 7.4%         | 250 7.4%        | 377 7.4%         |
| < 3 mm                        | 618 36.1%        | 1,110 32.8%     | 1,728 33.9%      |
| 3–5 mm                        | 733 42.8%        | 1,461 43.1%     | 2,194 43.0%      |

(Continued)
### Table 1 (Continued)

|                          | JR-NET1 (n = 1,714) | JR-NET2 (n = 3,388) | Total (n = 5,102) |
|--------------------------|---------------------|---------------------|------------------|
| **Age**                  | 64.12 ± 14.08       | 64.50 ± 14.56       | 64.37 ± 14.40    |
| 10–20 mm                 | 205                 | 448                 | 653              |
| ≥ 20 mm                  | 28                  | 39                  | 67               |
| Unknown                  | 3                   | 80                  | 83               |
| **Shape**                | 871                 | 1,652               | 2,523            |
| Small size/Small neck    | 604                 | 1,145               | 1,749            |
| Large                    | 205                 | 434                 | 639              |
| Giant                    | 23                  | 24                  | 47               |
| Non-saccular             | 0                   | 57                  | 57               |
| Unknown                  | 11                  | 76                  | 87               |
| **Surgery**              |                     |                     |                  |
| Emergency                | 1,522               | 3,008               | 4,530            |
| Unknown                  | 5                   | 0                   | 5                |
| **Responsible doctor**   |                     |                     |                  |
| Supervisory doctor       | 941                 | 1,488               | 2,429            |
| Specialist               | 506                 | 1,696               | 2,202            |
| Non-specialist           | 261                 | 203                 | 464              |
| Unknown                  | 6                   | 1                   | 7                |
| **Anesthesia**           |                     |                     |                  |
| General anesthesia       | 1,360               | 2,627               | 3,987            |
| Local anesthesia         | 349                 | 756                 | 1,105            |
| Unknown                  | 5                   | 5                   | 10               |
| **Day of treatment**     |                     |                     |                  |
| Within 24 hours          | 762                 | 2,176               | 2,938            |
| Within 72 hours          | 545                 | 583                 | 1,128            |
| Within 7 days            | 185                 | 195                 | 380              |
| Within 14 days           | 62                  | 80                  | 142              |
| After 15 days            | 156                 | 262                 | 418              |
| Unknown                  | 4                   | 92                  | 96               |
| **Angiography system used** |                   |                     |                  |
| Single plane             | 864                 | 1,491               | 2,355            |
| Bi-plane                 | 850                 | 1,828               | 2,678            |
| Unknown                  | 0                   | 69                  | 69               |
| **3D rotationalangiography** |                   |                     |                  |
| Not used                 | 564                 | 833                 | 1,397            |
| Used                     | 1,149               | 2,475               | 3,624            |
| Unknown                  | 1                   | 80                  | 81               |
| **Treatment strategy**   |                     |                     |                  |
| Simple technique         | 1,371               | 2,272               | 3,643            |
| Balloon-assisted technique | 242               | 789                 | 1,031            |
| Double catheter technique | 43                 | 192                 | 235              |
| Stent                    | 6                   | 53                  | 59               |
| PAO                      | 42                  | 0                   | 42               |
| Other                    | 0                   | 8                   | 8                |
| Unknown                  | 10                  | 74                  | 84               |

(Continued)
Table 1 (Continued)

|                | JR-NET1 (n = 1,714) | JR-NET2 (n = 3,388) | Total (n = 5,102) |
|----------------|---------------------|---------------------|------------------|
| **Age**        | 64.12 ± 14.08       | 64.50 ± 14.56       | 64.37 ± 14.40    |
| **Coil used**  | Bare platinum       | 1,692               | 98.7%            |
|                | Bioactive            | 0                   | 0.0%             |
|                | Unknown              | 22                  | 1.3%             |

| **Result of occlusion** | AT 31 1.8% | BF 146 8.5% | NR 515 30.0% | CO 984 57.4% | PAO 33 1.9% | Unknown 5 0.3% |
|-------------------------|------------|-------------|-------------|-------------|------------|-------------|

| **Number of preoperative antiplatelet drugs used** | 0 | 1 | 2 | 3 | Unknown |
|---------------------------------------------------|---|---|---|---|---------|
| 1                                                  | 70 4.1% | 336 9.9% | 406 8.0% |
| 2                                                  | 27 1.6% | 102 3.0% | 129 2.5% |
| 3                                                  | 0 0.0%  | 4 0.1%   | 4 0.1%   |
| Unknown                                            | 30 1.8% | 135 4.0% | 165 3.2% |

| **Outcome** | Good 1,257 73.3% | Poor 457 26.7% | Unknown 0 0.0% |
|-------------|------------------|----------------|----------------|
|             | 2,207 65.1%     | 1,049 31.0%    | 132 3.9%       |
|             | 3,464 67.9%     | 1,506 29.5%    | 132 2.6%       |

| **Complication** | Hemorrhage during procedure 87 5.1% | Rebleeding after treatment 46 2.7% | Ischemia 110 6.4% |
|------------------|--------------------------------------|-----------------------------------|------------------|
|                  | 140 4.1%                            | 27 0.8%                           | 217 6.4%         |
|                  | 227 4.5%                            | 73 1.4%                           | 327 6.4%         |

ACA: anterior cerebral artery, AT: attempt, BA: basilar artery, BF: body filling, CO: complete occlusion, ICA: internal carotid artery, MCA: middle cerebral artery, mRS: modified Rankin Scale, NR: neck remnant, PAO: parent artery occlusion, PCA: posterior cerebral artery, Pcom: posterior communicating artery, 3D: three dimensional, VA: vertebral artery, WFNS: World Federation of Neurosurgical Societies.

reclassified into Pcom, distal ICA (ICA-ant. choroidal and ICA-bif (internal carotid artery bifurcation), or proximal ICA (ICA-cavernous and ICA-paraclinoid). Others (ant. circulation) were not classifiable and therefore reclassified as unknown sites. Shapes of aneurysms were classified into five categories: small size/small neck (maximum diameter was less than 10 mm and neck size was less than 4 mm, and ratio to maximum diameter and neck size was 1.5 or over), small size/wide neck (maximum diameter was less than 10 mm and neck size was 4 mm or over, or ratio to maximum diameter and neck size was less than 1.5), large (maximum diameter was 10–25 mm, giant (maximum diameter was 25 mm or over), and non-saccular aneurysm.

Closed-circuit system general anesthesia with controlled ventilation by endotracheal intubation or laryngeal mask was classified into general anesthesia. Other anesthetic techniques such as sedatives without controlled ventilation were classified into local anesthesia. The responsible doctor for the treatment was classified into a supervisory doctor, specialist, and non-specialist of Japanese Society for Neuroendovascular Therapy (JSNET). The dates of treatment were classified into five categories: within 24 hours, within 72 hours, within 7 days, within 14 days, and after 15 days. Treatment strategies were classified into simple technique, double catheter technique, balloon-assisted, stent-assisted, parent artery occlusion, and others. Coils used were classified as either a bare platinum coil alone or combination with a bioactive coil. As to the antiplatelet drugs (aspirin, ticlopidine, cilostazol, and clopidogrel), the preoperative number was used as a character and
the perioperative and postoperative numbers were not. Complications were classified into hemorrhagic complications during procedure, rebleeding after treatment, and all ischemic complications within 30 days of treatment.

The modified Rankin Scale (mRS) score 30 days after treatment was used to divide patients into good (0–3) and poor (4–6) outcome groups. These groups were statistically analyzed, using the statistical analysis software JMP 10 (SAS Institute Inc., Cary, North Carolina, USA) and univariate and multivariate methods with a level of significance of < 0.05.

**Results**

In the univariate analysis, the factors that had statistically significant effects on the outcome on day 30 were the age, sex, mRS score before onset, WFNS classification, site, size, shape, emergency operation, responsible doctor for treatment, day of treatment, 3D rotational angiography, result of occlusion, preoperative use of antiplatelet drugs, perioperative hemorrhagic complications, rebleeding, and all ischemic complications (Table 2).

The multivariate analysis revealed that young patients, patients with low mRS scores before onset, and patients with low WFNS grades had good outcome. Compared to proximal ICA aneurysms, the odds ratios of MCA and ACA aneurysms were 1.67 and 1.46, respectively, indicating poorer outcome for MCA aneurysms. Regarding the shape of cerebral aneurysm, patients with small size/wide neck cerebral aneurysms had poor outcome. Patients who underwent treatment after 15 days had better outcome than those who underwent treatment during other periods. The timing of treatment, however, did not influence the outcome in patients who underwent treatment within 14 days. Compared to cases in which the responsible doctor for the treatment was a supervisory doctor, the

| Table 2  Risk factors associated with poor outcome |
|-----------------------------------------------|
|                                         | Univariate analysis | Multivariate analysis |
|                                         | p value             | p value             | Hazard ratio (95% CI) |
| Age                                      | < 0.001             | < 0.001             | 1.05 (1.04–1.06)     |
| Female                                   | 0.001               | 0.652               | 0.96 (0.78–1.16)     |
| mRS score before onset                   | < 0.001             | < 0.001             | –                   |
| 0                                        |                     |                     |                     |
| 1                                        | 0.297               | 0.85 (0.62–1.16)    |
| 2                                        | 0.295               | 0.82 (0.56–1.19)    |
| 3                                        | 0.761               | 0.94 (0.62–1.39)    |
| 4                                        | < 0.001             | 2.07 (1.47–2.92)    |
| 5                                        | 0.012               | 1.57 (1.10–2.25)    |
| WFNS classification                      | < 0.001             | < 0.001             | –                   |
| 1                                        |                     |                     |                     |
| 2                                        | < 0.001             | 2.25 (1.61–3.21)    |
| 3                                        | < 0.001             | 4.27 (3.01–6.15)    |
| 4                                        | < 0.001             | 15.84 (11.38–22.47) |
| 5                                        | < 0.001             | 48.35 (33.86–70.30) |
| Site                                     | < 0.001             | 0.013               |                     |
| ACA                                      | 0.087               | 1.46 (0.95–2.30)    |
| Pcom                                     | 0.953               | 1.01 (0.65–1.59)    |
| Distal ICA                                | 0.463               | 1.24 (0.70–2.20)    |
| Proximal ICA                              | –                   |                     |                     |
| MCA                                      | 0.047               | 1.67 (1.01–2.81)    |
| BA                                       | 0.766               | 1.07 (0.69–1.70)    |
| VA, PCA                                   | 0.6                 | 1.14 (0.70–1.89)    |

(Continued)
Table 2 (Continued)

|                      | Univariate analysis | Multivariate analysis |
|----------------------|---------------------|-----------------------|
|                      | p value             | p value               |
|                      | Hazard ratio (95% CI) |
| **Size**             |                     |                       |
| < 3 mm               | < 0.001             | 0.524                 |
| 3–5 mm               | 0.114               | 1.31 (0.94–1.85)      |
| 5–10 mm              | 0.098               | 1.33 (0.95–1.87)      |
| 10–20 mm             | 0.594               | 1.21 (0.59–2.48)      |
| ≥ 20 mm              | 0.448               | 1.67 (0.45–6.38)      |
| **Shape**            | < 0.001             | 0.227                 |
| Small size/small neck|                     |                       |
| Small size/wide neck | 0.044               | 1.21 (1.00–1.45)      |
| Large                | 0.245               | 1.48 (0.76–2.89)      |
| Giant                | 0.291               | 2.22 (0.50–9.64)      |
| Non-saccular         | 0.352               | 1.58 (0.60–4.04)      |
| **Emergency surgery**| < 0.001             | 0.512                 |
| **Responsible doctor**| < 0.001             | 0.006                 |
| Supervisory doctor   |                     |                       |
| Specialist           | 0.004               | 1.29 (1.09–1.54)      |
| Non-specialist       | 0.029               | 1.40 (1.03–1.89)      |
| **General anesthesia**| 0.08                | 0.945                 |
| Day of treatment     | < 0.001             | 0.308                 |
|                      |                     |                       |
| Within 24 hours      |                     |                       |
| Within 72 hours      | 0.987               | 0.99 (0.81–1.22)      |
| Within 7 days        | 0.86                | 0.97 (0.70–1.34)      |
| Within 14 days       | 0.93                | 1.02 (0.59–1.77)      |
| After 15 days        | 0.032               | 0.62 (0.40–0.96)      |
| **Angiography system used**| 0.571              |                       |
| 3D rotational angiography | 0.008              | 0.049                 |
| Treatment strategy   | 0.354               |                       |
| Simple technique     |                     |                       |
| Balloon-assisted technique |           |                       |
| Double catheter technique |           |                       |
| Stent                |                     |                       |
| PAO                 |                     |                       |
| Other               |                     |                       |
| Bioactive coil       | 0.09                | 0.009                 |
| Result of occlusion  | < 0.001             | < 0.001               |
| AT                  | 0.01                | 3.54 (1.34–9.66)      |
| BF                  | < 0.001             | 1.78 (1.33–2.39)      |
| NR                  | 0.826               | 1.98 (0.82–1.18)      |
| CO                  | –                   |                       |

(Continued)
odds ratios of cases in which the responsible doctor for the treatment was a specialist and a non-specialist were 1.29 and 1.40, respectively, indicating that the outcome was poorer when the responsible doctor for the treatment was a specialist or a non-specialist.

Regarding coils used for embolization, the outcome of patients treated with bare platinum coils was better (odds ratio: 0.70). Regarding the result of occlusion, there was no statistically significant difference between patients who completed treatment with neck remnant and those with complete occlusion (CO); the outcome of patients who completed treatment with body filling (BF) was poorer, with statistical significance, than in patients with CO (odds ratio: 1.78). The sex, size of aneurysm, anesthetic technique, or treatment strategy did not show a correlation with the outcome on day 30.

Regarding complications, perioperative hemorrhagic complications occurred in 4.5% (227/5,102), all ischemic complications occurred in 6.4% (327/5,102), and rebleeding occurred in 1.4% (73/5,102) of patients. The results of the multivariate analysis showed that all these complications were poor outcome factors on day 30, with odds ratios of 2.72, 2.96, and 25.49, respectively.

### Discussion

The incidence of subarachnoid hemorrhage in Japan has been reported to be approximately 20 per year per 100,000 population; that is, it affects about 25,000 patients per year there. Based on annual report of Japan Neurosurgical Society (JNS), about 15,000 procedures for aneurysmal subarachnoid hemorrhage were registered annually. 122 and 150 institutions participated from JR-NET1 and JR-NET2, and our data were obtained from 200 of 387 specialists (51.7%) of JSNET in JR-NET1, and 256 of 488 specialists (52.5%) in JR-NET2, respectively. Given these considerations, they are considered sufficient to show the current status of endovascular treatment for ruptured cerebral aneurysm in Japan, although the study sites accounted for only approximately 50% of all institutions.

According to demographic data, grade-5 patients accounted for 14% (Table 1), suggesting that rebleeding was actively prevented by endovascular treatment, as previously reported, although the prevention was not recommended in the guidelines. As with the ISAT, MCA aneurysms accounted for only 6% of the sites of treatment, and arteries in the posterior fossa including BA and VA accounted for 26%, suggesting that endovascular treatment was considered suitable for lesions in the posterior fossa and surgical treatment was considered suitable for MCA aneurysms as previously reported. Although there were no differences between JR-NET1 and JR-NET2 in any of the items evaluated, treatment mainly by specialists was becoming more widely performed in JR-NET2, accounting for approximately 50% of all treatments, because of widespread use of...
endovascular treatment in Japan. Bi-plane angiography and 3D rotational angiography tended to be used with increased frequency. The perioperative use of heparin and postoperative use of anticoagulant therapy or antiplatelet drugs were excluded from the characters for the present study, because they were considered susceptible to the result of treatment.

The mRS score on day 30 was used to assess the outcome of subarachnoid hemorrhage, because these data were obtained in studies that enrolled patients within 30 days of treatment. Patients with an mRS score of 0 to 3 were classified as having good outcome, and the percentage of patients with good outcome was significantly higher among young patients with symptoms that were classified as mild according to the WFNS classification, as reported elsewhere. It may be necessary to assess the outcome after long follow-up such as after 1 or 2 years.

Regarding the sites of treatment, patients with MCA aneurysms were more likely to have poor outcome, suggesting that their angioanatomy of MCA aneurysm was difficult to treat by endovascular intervention, as stated in the American Heart Association (AHA) Guidelines. However, we could not assess the relationship between the angioanatomical difficulty of MCA aneurysms and their outcomes, because there was no information about neck size of aneurysms of more than 10 mm. In recent years, successful outcomes of endovascular treatment for ruptured cerebral aneurysms of less than 3 mm have been reported. Though small cerebral aneurysms have been reported to be a risk factor for perioperative rupture of cerebral aneurysms, there was no correlation between the size of cerebral aneurysm and its outcome. However, a small-size/wide-neck cerebral aneurysm was a poor outcome factor in the present study.

The rate of ischemic complication at the treatment of small-size/wide-neck was significantly higher (7.8%) than that of other shapes, and this result may be the reason of their poorer outcome.

As stated in the guidelines for the management of stroke, treatment within 72 hours of onset is a common approach to prevent rebleeding from ruptured cerebral aneurysms. In the present study, however, the percentage of patients with good outcome was high among those who underwent treatment after 15 days. This may be a result of aggressive treatment for patients who were expected to have good neurologic prognosis when an elective surgery was performed. The use of 3D rotational angiography, which has been becoming increasingly prevalent in recent years, was a good outcome factor on day 30. For safe endovascular treatment, it is necessary to perform 3D rotational angiography to obtain a clear picture of the relationship between a cerebral aneurysm and its parent artery. In the present study, bioactive coils were not shown to be useful as reported elsewhere, and bare platinum coils were shown to have a better outcome. The reason may be that the rate of hemorrhagic complications during procedure was significantly higher (5.0%) on the treatment by bioactive coils than bare platinum coils.

The outcome was poor for untreated patients, which suggested the need for rebleeding prevention. The outcome was also poor for patients in whom the outcome of occlusion was PAO, probably because patients with PAO were unintentionally included. The outcome was also poor for patients in whom the result of occlusion was BF, probably because the rate of rebleeding after the treatment and ischemic complications was significantly higher than other results of occlusion, 4.6% and 10.8% respectively. The outcome for patients treated by a supervisory doctor was better than that for patients treated by a specialist or non-specialist alone, suggesting that the success of endovascular treatment is dependent on the amount of experience which the responsible doctor for the treatment has at performing the treatment.

Perioperative hemorrhagic complications, all ischemic complications, and rebleeding influenced the outcome, with odds ratios of 2.72, 2.96, and 25.49, respectively. The incidence of hemorrhagic complications that occurred during treatment was 4.5%, as reported elsewhere. In the present study, however, the incidence of hemorrhagic complications that might affect the outcome was unclear. With recent advances in the technique of perioperative blood flow interruption using a balloon-tipped guiding catheter and balloon catheter, it is expected that the incidence will continue to decrease. All ischemic complications occurred in 6.4% of all patients, as reported elsewhere, and the incidence of rebleeding from ruptured aneurysms within 30 days was 1.4% in the present study. Since differences in treatment strategy did not affect the outcome, selection of appropriate treatment is necessary for the prevention of these complications.

**Conclusion**

The results of the retrospective registry studies conducted on data accumulated in Japan from 2005 to 2009 showed that the factors that affected

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the outcome on day 30 were perioperative hemorrhagic complications, all ischemic complications, rebleeding, age, WFNS classification, MCA aneurysms, small-size/wide-neck cerebral aneurysm, use of 3D rotational angiography, treatment in the absence of the supervisory doctor, and BF as a result of treatment.

Thus, we reported here on the current status of endovascular treatment for ruptured cerebral aneurysms in Japan. We must be fully aware of these risk factors and determine indications for the treatment when endovascular treatment is performed as the treatment of choice for ruptured cerebral aneurysm.

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Conflicts of Interest Disclosure

All authors who are members of JNS have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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