Predictors of Angiographic Changes in Neck Remnants of Ruptured Cerebral Aneurysms Treated With Guglielmi Detachable Coils

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Abstract

The angiographic changes in neck remnants of ruptured cerebral aneurysms treated with Guglielmi detachable coils (GDCs) were evaluated in the acute stage to analyze the important radiological and clinical factors. The clinical and radiological data of 37 patients with a residual neck of a ruptured cerebral aneurysm treated with GDC were reviewed. The angiographic changes on follow-up angiography were classified into three groups: recanalization of the neck remnant, progressive thrombosis, and unchanged. The effects of the clinical and angiographic findings, such as patient age, follow-up period, type of aneurysm (terminal type or side wall type), dome diameter, neck size, dome/neck ratio, obliteration rate, and volume embolization ratio were investigated. Recanalization of the neck remnant was observed in 18 of 37 cases, progressive thrombosis in nine, and unchanged in 10. The type of aneurysm, dome diameter, neck size, and volume embolization ratio were correlated with changes in the neck remnant. The aneurysm dome diameter and type of aneurysm were independent predictive factors for the recanalization of neck remnants on follow-up angiography. Dome diameter of less than 4.5 mm and volume embolization ratio of more than 31% in side wall aneurysms were likely to lead to progressive thrombosis.

Key words: intracranial aneurysm, neck remnant, endovascular therapy, terminal type, side wall type

Introduction

The Guglielmi detachable coil (GDC) procedure has been widely used since its introduction in 1991.8,10) Recent technical developments now allow safe and reliable treatment of ruptured cerebral aneurysms in selected patients.1,17,19,23,24) However, GDC treatment has not achieved the rates of complete cure seen after surgical clipping.5,11,14,25,31) Complete occlusion of aneurysms at the initial GDC embolization may be influenced by several factors, including aneurysm morphology (aneurysm dome size, neck size, dome/neck ratio) and the relationship to the major neighboring artery.6,15,28,31) Moreover, aneurysm neck size, dome size, treatment timing, follow-up period, and the immediate outcome whether complete angiographic embolization is achieved at initial treatment are predictors of the long-term angiographic results.11,13,25) Aneurysms that are incompletely treated are more unstable than those that are treated completely by GDC embolization. However, few follow-up studies have investigated the angiographic changes in neck remnants.

The present study investigated the angiographic changes, particularly in the neck remnants of ruptured cerebral aneurysms treated with GDCs, and analyzed the radiological and clinical factors affecting the follow-up angiographic changes.
Clinical Materials and Methods

I. Patient population

From March 1997 through December 2004, 472 patients with acute subarachnoid hemorrhage due to ruptured cerebral aneurysms were admitted to our hospital. Our policy to initially consider treatment with the GDC system, provided the following conditions are met: better than Hunt and Kosnik grade IV, saccular aneurysm, and angiography clearly identified the neck of the aneurysm and the surrounding arterial branches. The GDC system was used to treat 221 patients with 221 aneurysms, whereas 80 patients with 80 aneurysms were treated with surgical clipping because the aneurysms were not suitable for GDC treatment. The remaining 171 patients were conservatively treated because of poor medical condition, including Hunt and Kosnik grade V or age 90 years or greater.

Treatment with the GDC system was performed during the acute stage within less than 7 days after onset of the subarachnoid hemorrhage (0.67 ± 0.63 days). The immediate angiographic outcome was classified into three groups: complete occlusion (no evidence of contrast medium flowing into the aneurysm) in 125 aneurysms (57%) in 125 patients, neck remnant (some contrast filling in the aneurysm neck) in 45 aneurysms (20%) in 45 patients, and body filling (some contrast filling in the dome) in 51 aneurysms (23%) in 51 patients. Follow-up angiography was performed on all patients with neck remnant on the following day, and then again at 7 days and at 3 months after embolization. Heparinization was performed during and/or up to 24 hours after the procedure in 92 of 221 patients (42%), so the conditions of coiling were considered unstable. In fact, two patients had rebleeding several hours after GDC embolization. Additional follow-up angiography was performed every year if necessary, especially in patients with recanalization of the neck remnants. Five patients with neck remnant refused or could not undergo follow-up angiography, so were excluded.

Finally, 40 aneurysms in 40 patients, 27 women and 13 men aged 27 to 78 years (mean 59.95 ± 11.32 years), with neck remnant were enrolled in this study. The period of follow-up angiography ranged from 5 to 29 months (mean 12.11 ± 5.07 months).

II. Method of GDC embolization

All procedures in this series were performed under general anesthesia for better control of the clinical conditions and to obtain high quality angiographic images. The standard method of aneurysm embolization was employed. A guiding catheter was placed in the internal carotid artery via the femoral artery. The GDC Tracker-10 catheter and GDC-10 coils were used in most aneurysms, with the GDC-18 system in large aneurysms. The procedure was sometimes discontinued in patients having aneurysms with a wide neck and/or elderly patients, if the dome, body, and identified rupture site were occluded despite leaving a discernible neck remnant. Any aneurysm with neck remnant and major recanalization on follow-up angiography considered to need additional treatment was retreated with further GDC embolization or surgical clipping.

III. Angiographic evaluation

All procedures were performed on a monoplane C-arm angiographic system with three-dimensional reconstruction (Integris V5000; Philips Medical Systems, Best, The Netherlands). The optimal visual working projection was established that could most clearly demonstrate the anatomical relationships, especially between the aneurysm dome, neck, and parent artery, as well as the surrounding branch arteries. This projection enabled us to practically evaluate the morphologic features of the aneurysms, including the type of aneurysm, dome diameter, neck size, and dome/neck ratio.

The side wall and terminal aneurysm types were determined as follows (Fig. 1). The aneurysm angle was determined by the angle between the axis of the aneurysm and the flow direction in the parent vessel. The axis of the aneurysm was defined as the linear line connecting the midpoint of the neck with the top of the aneurysm. A curved or winding flow direction in the parent artery was approximated by the direction of the proximal portion adjacent to the neck in the parent artery. Side wall aneurysm was defined as originating from the side wall of the parent artery with an aneurysm angle from 0° to 135° (Fig. 2A), and terminal aneurysm was defined as originating at the terminal end of the parent artery with an aneurysm angle from 135° to 160° (Fig. 2B). As the aneurysm angles from 135° to 160° were equivocal, such aneurysms (one anterior communicating artery aneurysm, one middle cerebral artery aneurysm, and one vertebral artery-posterior inferior cerebellar artery aneurysm) were excluded from this study (Fig. 2C). Moreover, successful occlusion of the side wall aneurysms and prevention of recanalization depended on protection of the inflow zone of the distal side of the neck. The number of occlusions of the inflow zone to that of the side wall aneurysms was investigated.

The angiographic images were converted into computer files with a scanner. The dome diameter, neck size, and aneurysm area were calculated using...
Fig. 1  **left:** Diagram demonstrating the aneurysm angle, defined as the angle between the axis of aneurysm and the flow direction in the parent artery. The axis of the aneurysm was defined as the linear line connecting the midpoint of the neck with the top of the aneurysm. The flow direction was approximated by the direction of the proximal portion adjacent to the neck in the parent artery.  **right:** Diagram depicting the relationship between the aneurysm angle, the axis of the aneurysm, and the flow direction in the parent artery. The side wall aneurysm is defined as aneurysm angle from $0^\circ$ to $135^\circ$. The terminal aneurysm is defined as aneurysm angle from $160^\circ$ to $180^\circ$.

Fig. 2  **A:** Left carotid angiogram showing an internal carotid-posterior communicating artery aneurysm as a representative side wall aneurysm, originating from the side wall of the parent artery with an aneurysm angle of $100^\circ$.  **B:** Left vertebral angiogram showing a basilar tip aneurysm as a representative terminal aneurysm, originating at the terminal end of the parent artery with an aneurysm angle of $180^\circ$.  **C:** Left carotid angiogram showing an anterior communicating artery aneurysm excluded from this study because the aneurysm angle was $145^\circ$.

Imaging software (Image, version 1.7; National Institutes of Health, Bethesda, Md., U.S.A.). The obliteration rate was calculated by the following formula\(^1\):

\[
\text{Obliteration rate (\%)} = \left(\frac{\text{GDC mass area}}{\text{total aneurysm area} (\text{GDC mass area} + \text{neck remnant area})}\right) \times 100
\]

The same visual working projections as used for the morphologic features of the aneurysms were employed for evaluating these dimensional parameters, and the same angiographic view was consistently used to compare these dimensional results during the procedure and on follow-up angiography. The changes in the obliteration rate from the initial angiographic result to the follow-up angiographic result were defined as follows:
Change in the obliteration rate
= (obliteration rate at follow-up angiography) − (obliteration rate at immediate postembolization)

In order to evaluate the degree of coil packing within the aneurysm more volumetrically, the volume embolization ratio was calculated using the following algebraic equation:

\[
\text{Volume embolization ratio} = \frac{(\text{volume of embolized coil})}{(\text{volume of the aneurysm})}
\]

The shape of the lesions was assumed to be elliptical, and the volumes were determined using the following equation:

\[
\text{Aneurysm volume} = \frac{4}{3} \times \pi \times \left(\frac{\text{length}}{2}\right) \times \left(\frac{\text{dome}}{2}\right)^2
\]

The volume of the coils was estimated using the following formula:

\[
\text{Volume of coils} = \pi \times \left(\frac{\text{OD}}{2}\right)^2 \times L
\]

where OD is the outside diameter of the coil (GDC size 18, 0.0381 mm; GDC size 10, 0.254 mm) and L represents the total length of the coils implanted in

Neurol Med Chir (Tokyo) 46, January, 2006
The follow-up angiographic results were classified into three groups as follows: recanalization of the neck remnant, changes in the obliteration rate $< -10$ (Fig. 3); progressive thrombosis of the neck remnant, changes in the obliteration rate $> 0$ (Fig. 4); and unchanged neck remnant, changes in the obliteration rate $-10 - 0$.

### IV. Statistics

All values are expressed as means $\pm$ standard deviation. A non-paired t-test was carried out to compare the three groups (recanalization, progressive thrombosis, and unchanged) according to the following data: age, follow-up period, aneurysm dome diameter (mm), aneurysm neck size (mm), dome/neck ratio, obliteration rate (%), changes in the obliteration rate (%), and volume embolization ratio (%). A chi-square test with Yate’s correction was performed to compare the proportion of aneurysm types, and the proportion of the number of occlusions in the inflow zone to the number of side wall aneurysms in the three groups.

A logistic regression analysis was performed using the factors statistically significant differences to determine any factors that were significantly related to the recanalization of the neck remnants. Moreover, linear regression analysis was performed to evaluate the importance of the dome size of the aneurysms and the volume embolization ratio, which may lead to progressive thrombosis. A $p$ value of less than 0.05 was considered statistically significant.

### Results

Nineteen aneurysms were the terminal type, and 18 aneurysms were the side wall type. The locations are shown in Table 1. The clinical and radiological data are summarized in Table 2. Eighteen aneurysms showed recanalization of the neck remnant, nine had progressive thrombosis, and 10 were unchanged on follow-up angiography. Eight aneurysms exhibited major recanalization that required additional treatment. Six patients underwent additional embolization and two were treated with surgical clipping. There were no complications during these additional procedures.

No statistically significant differences were observed between the three groups regarding mean age, follow-up period, dome/neck ratio, and obliteration rate. However, statistically significant differences were observed in terms of aneurysm location ($p < 0.01$). Terminal aneurysms were common in the recanalization group (16 of 18 cases), whereas side wall aneurysms were common in the progressive thrombosis (7 of 9 cases) and unchanged groups (9 of 10 cases). The proportion of embolizations of the inflow zone in side wall aneurysms was similar in the three groups. The mean aneurysm dome diameter and the mean neck size in the recanalization group were larger than in the progressive thrombosis and unchanged groups (both $p < 0.01$). The mean volume embolization ratio was highest in the progressive thrombosis group ($p < 0.01$).

In general, small aneurysms have small necks, and large and giant aneurysms have wide necks, so simple regression analysis was performed to assess the association between aneurysm size and neck size. There was a significant linear correlation between aneurysm size and neck size in our study population ($Y = 2.083 + 1.433X$, $r^2 = 0.617$, $p < 0.0001$).

Logistic regression analysis revealed that the type of aneurysm (the terminal type: odds ratio 184.853, 95% confidence interval 3.707–9217.441, $p < 0.01$) and dome diameter (odds ratio 2.965, 95% confidence interval 1.037–8.475, $p < 0.05$) were independent predictors of the recanalization of neck remnants on follow-up angiography.

Linear regression analysis demonstrated that the changes in the obliteration rate were significantly related to the aneurysm dome size ($p < 0.01$). Aneurysms with a dome diameter of less than 4.5 mm were more likely to lead to progressive thrombosis after GDC treatment (Fig. 5). Moreover,
Table 2  Clinical and radiological characteristics of the three groups

<table>
<thead>
<tr>
<th></th>
<th>Recanalization 18 cases</th>
<th>Progressive thrombosis 9 cases</th>
<th>Unchanged 10 cases</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>61.56 ± 12.42</td>
<td>61.00 ± 8.19</td>
<td>56.10 ± 11.77</td>
<td>0.46</td>
</tr>
<tr>
<td>Follow-up period (month)</td>
<td>12.89 ± 4.46</td>
<td>11.56 ± 7.52</td>
<td>11.20 ± 3.58</td>
<td>0.67</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>terminal type</td>
<td>16</td>
<td>2</td>
<td>1</td>
<td>0.0001</td>
</tr>
<tr>
<td>side wall type</td>
<td>2</td>
<td>7</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Embolization of inflow zone in side wall type aneurysm</td>
<td>1/2</td>
<td>4/7</td>
<td>4/9</td>
<td>0.88</td>
</tr>
<tr>
<td>Dome diameter (mm)</td>
<td>8.22 ± 2.97</td>
<td>4.17 ± 1.07</td>
<td>5.49 ± 1.48</td>
<td>0.0002</td>
</tr>
<tr>
<td>Neck size (mm)</td>
<td>3.98 ± 1.70</td>
<td>2.18 ± 0.85</td>
<td>2.29 ± 0.69</td>
<td>0.0014</td>
</tr>
<tr>
<td>Dome/neck ratio</td>
<td>2.51 ± 2.96</td>
<td>1.73 ± 0.57</td>
<td>2.49 ± 0.81</td>
<td>0.64</td>
</tr>
<tr>
<td>Obliteration rate (%)</td>
<td>85.89 ± 4.36</td>
<td>88.42 ± 4.86</td>
<td>85.39 ± 3.76</td>
<td>0.17</td>
</tr>
<tr>
<td>Change in obliteration rate (%)</td>
<td>−35.09 ± 35.09</td>
<td>10.99 ± 7.54</td>
<td>−1.90 ± 3.12</td>
<td>0.0001</td>
</tr>
<tr>
<td>Volume embolization ratio (%)</td>
<td>20.96 ± 8.22</td>
<td>32.71 ± 7.73</td>
<td>23.22 ± 8.60</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation.

Fig. 5 Correlation between the aneurysm dome size and the change in the obliteration rate (change in obliteration rate = 23.704 − 5.443 × dome size, r² = 0.319, p < 0.01).

Fig. 6 Correlation between the volume embolization ratio and the change in the obliteration rate (change in obliteration rate = −60.817 + 1.982 × volume embolization ratio, r² = 0.266, p < 0.01).

linear regression analysis revealed that the changes in the obliteration rate were significantly related to the volume embolization ratio (p < 0.01). Aneurysms with volume embolization ratio of more than 31% were more likely to lead to progressive thrombosis on follow-up angiography (Fig. 6).

Discussion

A previous series of aneurysms treated by GDC embolization resulted in a remnant in 21.4% of small aneurysms with a small neck, in 57.1% of large aneurysms, and in 50% of giant aneurysms at the initial treatment. Recanalization on follow-up angiography after GDC embolization is more frequent after incomplete embolization than complete embolization. A previous follow-up angiographic study demonstrated recurrence in 40.1% of aneurysms with residual necks, but in only 20.0% of aneurysms with complete embolization. In our institutes, recanalization on follow-up angiography was seen in only 13 of 125 aneurysms (10.4%) after complete embolization, but 18 of 37 aneurysms (49%) with neck remnants. The present study revealed progressive thrombosis in 24% of aneurysms with neck remnants, and no change was observed in 27%. Follow-up angiography showed unstable changes in aneurysms embolized by the current GDC system, especially if the embolization was incomplete.

Previous studies reported that the best long-term angiographic results are associated with complete embolization.
occlusion at the initial GDC embolization,\textsuperscript{13} small neck size, small dome size, ruptured aneurysm, follow-up period, vasospasm, and treatment timing.\textsuperscript{13,25} The present study analyzed the angiographic and clinical factors affecting such angiographic changes, including dome diameter, neck size, dome/neck ratio, obliteration rate, volume embolization ratio, and aneurysm location. The aneurysms were divided into terminal and side wall aneurysms based on location and direction in relation to the parent artery and the blood flow into the aneurysms, because the changes in aneurysms treated with coil embolization were thought to be influenced by the hemodynamics between the aneurysm and the parent artery.\textsuperscript{2,3,7}

Our analysis indicated that angiographic changes are strongly related to aneurysm location (terminal type or side wall type), aneurysm dome diameter, neck size, and volume embolization ratio. Recanalization was more often seen in aneurysms with larger dome and neck sizes, whereas progressive thrombosis and absence of changes were seen in aneurysms with smaller dome and neck sizes. These findings are compatible with previous studies. Moreover, recanalization was much more common in terminal aneurysms, whereas progressive thrombosis and absence of change were more common in side wall aneurysms. This issue was significantly related to angiographic outcome. A previous study on the association between recurrence and aneurysm location demonstrated that basilar bifurcation aneurysms tend to undergo recanalization more than any other aneurysms, although there was no statistical significance.\textsuperscript{25} However, this previous study did not divide the aneurysms in terms of hemodynamics or flow angle in relation to the parent artery.

Several previous studies using computational fluid dynamics analysis have found that embolization of the inflow zone in side wall aneurysms is important for the prevention of recanalization, because blood flow enters the aneurysm from the distal side of the neck.\textsuperscript{7,12} However, no statistical significance was observed in the current study. In fact, the dome size, aneurysm type, volume embolization ratio, and other variables were more significantly related to the prediction of the angiographic changes, so further clinical study with stratification of those parameters is needed to clarify this issue.

Interestingly, the dome/neck ratio had no statistically significant effect. This ratio may not be important for the angiographic follow up of aneurysms treated with GDC. The dome/neck ratio may be mainly correlated with the occlusion rate of aneurysms by endovascular packing with GDCs at the time of initial treatment, and with the stability of the coils packed within aneurysms.\textsuperscript{4,15,28}

The present study found no significant difference in obliteration rate between the three groups, although the progressive thrombosis group tended to have a higher obliteration rate than the other two groups. On the other hand, the volume embolization ratio did show significant differences between the three groups, and was significantly correlated with changes in the obliteration rate seen as angiographic changes. Previous angiographic evaluation of the percentage of occlusion, such as the obliteration rate at the initial treatment, did not always predict the long-term stability of GDC-embolized aneurysms. These findings suggest that volumetric occlusion may be more important for predicting the outcome of GDC-embolized aneurysms.\textsuperscript{27,30}

Multivariate analyses, supplemented by logistic regression analyses, revealed that the type of aneurysm (terminal type or side wall type) and the aneurysm diameter were independent predictive factors for recanalization of neck remnants on follow-up angiography. Aneurysm neck size had no independent predictive value in this analysis, presumably because there was a significant linear correlation between aneurysm size and neck size based on the outcome of single regression analysis ($Y = 2.083 + 1.433X$, $r^2 = 0.617$, $p < 0.0001$). Therefore, neck size did not show independent predictive value, but had the same value as dome size, which had independent predictive value for aneurysm recanalization. Wide neck and terminal aneurysms receive hemodynamic forces more directly on a larger surface area of the coil ball at the neck of the aneurysm. These data are supported by the experimental finding that this is an important factor in the stability of residual aneurysms.\textsuperscript{7,16,26}

From the clinical point of view, any factors associated with progressive thrombosis are very important to identify. Our present findings suggest that dome diameter less than 4.5 mm and volume embolization ratio of more than 31% in side wall aneurysms may lead to progressive thrombosis on follow-up angiography, even if complete occlusion was not achieved at initial treatment. However, terminal aneurysms with larger domes and necks can be regarded as unstable and may lead to recanalization. Close observation after GDC embolization is needed for terminal aneurysms or aneurysms with larger domes and necks, especially if embolization is incomplete.

Treatment strategies for ruptured aneurysms should consider the present findings. For example, middle cerebral artery aneurysm occurring as termi-
nal aneurysm with large dome size and broad neck should initially be considered for surgical clipping, because large terminal aneurysms with a broad neck have a lower rate of complete embolization,\(^{19,28}\) and the location is relatively easy to approach. In addition, this study revealed that incompletely embolized aneurysms have a higher rate of recanalization. Further development of endovascular treatments such as biologically active GDCs are needed.\(^{16,20–22}\) The most important consideration in determining the treatment strategy for aneurysms is understanding the merits and demerits of both surgical clipping and GDC embolization, and maximizing the advantages to be gained from both types of intervention.

References

Predictors of Angiographic Changes in Neck Remnants

This is another excellent report by the Ibaraki neurosurgery group and colleagues, on predictors of angiographic change after GDC coiling. They analyze specifically 37 cases among 221 coiled aneurysms during a near seven-year period, that had neck remnants after acute coiling. Three cases that were borderline between terminal type and side wall type aneurysms were excluded. The study assesses potential risk factors of recanalization, versus stable appearance or progressive thrombosis during follow-up period of 5–29 months (mean 12 months).

The authors performed sophisticated volume measurements and obliteration indices, and also a number of multivariable statistical analyses using regression models. They confirmed a dramatic predictability of recanalization in 16 of 19 terminal type aneurysms, but only 2 of 18 side wall type aneurysms (p = 0.0001). This significant correlation persisted as an independent predictor in multivariate analyses controlling for many other aneurysm and host features. While this is not a new finding, such a robust predictive correlation mandates a very careful watch with much closer surveillance, and even perhaps prophylactic retreatment in terminal type aneurysms with neck remnants. A much more favorable course is expected with side wall type aneurysms regardless of other aneurysm parameters.

Other correlations of recanalization with aneurysm dome size, neck size, and other parameters of incomplete obliteration were “significant” but less dramatic, representing associations rather than predictive thresholds. They confirm more likely recanalization in larger aneurysms, hardly a new observation.

The study does not address the recanalization risks in 51 cases of sac residual filling rather than neck remnants, or even the recanalization risks in completely obliterated lesions during the same period. These are situations where recanalization was indeed less common, but still dreadfully unpredictable, including a number of rebleeds. We also remain unclear about the impact, if any, of technical improvements, learning curve, and new coil configurations during the course of the study-advances that had promised to solve some of these persisting problems. We remain amazed at the rate of growth of aneurysms after partial coiling, far exceeding any such rate with partial clipping or even the natural history of untreated unruptured aneurysm. We used to think that incomplete coiling of a ruptured aneurysm converted it into an unruptured lesion; but now we know that with neck remnants, dramatic growth is expected in more than half the cases, and nearly all terminal type lesions. This is a far more dire scenario than the

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natural history of unruptured aneurysm. The biology and hemodynamics of the incompletely coiled lesion clearly destabilize the aneurysm, notably in those with direct water hammer flow into the lesion.

The authors are congratulated on their thorough and rigorous “dissection” of information from their series. As a result, we all should be seriously cautious about near certainty of aneurysm recanalization after any neck remnant in terminal type aneurysm, and less worried about it in side wall type aneurysms.

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I have read this article with great interest. The authors beautifully record the fate of 37 ruptured aneurysms which have neck remnants after treatment with Guglielmi detachable coils from March 1997 through December 2004. The authors postulate that the factors of angiographic changes in neck remnants of ruptured cerebral aneurysms treated with Guglielmi detachable coils were the types of aneurysm, dome diameter, neck size, and volume embolization ratio. They reported that the independent predictors for recanalization of neck remnants on follow-up angiography were the aneurysm dome diameter and type of aneurysm.

The authors suggest that treatment strategies for ruptured aneurysms, especially middle cerebral aneurysm occurring as terminal aneurysm with large dome size and broad neck, should initially be considered for surgical clipping.

We are absolutely agree with the authors’ assessment. In the treatment of ruptured cerebral aneurysms, we should consider surgical clipping rather than coil embolization for terminal aneurysms with larger domes and necks.

Reference


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The obliteration of a cerebral aneurysm by coil packing still has several problems such as coil compaction or aneurysmal re-growth. Especially when initial coil embolization resulted in neck remnant, this eventually causes a serious follow-up problem. This paper suggests some answers to questions about the fate of the neck remnant. The embolization ratio and the axis of an aneurysm in relation to its parent artery showed strong relationships with recanalization. The terminal type aneurysm is more likely to recanalize compared to the side wall type. There has been no clear definition about the technical term terminal type and side wall type in relation to coil embolization. The value of this paper is that the terminal type and the side wall type were separated by one measurement of an angle determined by angiography. There are several reports that the aneurysm at the basilar bifurcation shows more frequent recanalization compared to aneurysms at other anatomical locations. This could be confirmed by the observations shown in this paper.

There are some new types of coil which might solve the recanalization problem. One of these new coils fills the aneurysmal sac more efficiently by using water expandable hydro-gel coated on the platinum surface. This type of coil showed lower recanalization rate compared to bare platinum coil. Adequate packing is the one of the most important keys to the future intervention of cerebral aneurysm. This paper showed another aspect of this important factor.

There are some limitations in the study. At first, the real size of the aneurysm differs to that observed by angiography due to the possible thrombus in the aneurysmal sac in the acute phase of subarachnoid hemorrhage and this might affect the true embolization ratio. The other is that the angle of the aneurysmal axis may not a true angle, and should be calculated from the three dimensional reconstruction.

Reference


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