# Practical Incidence of Complications and Degree of Patient Satisfaction After Endovascular Coil Embolization for Unruptured Intracranial Saccular Aneurysm Based on Patients' Surveys

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■ OBJECTIVE: **Endovascular treatment for unruptured intracranial aneurysms (UIAs) has been regarded as second to none management nowadays as the result of its proven efficacy and need for less-invasive treatment. Most researchers have focused on the anatomical outcome after endovascular treatment, so in this study we estimated the real incidence of untoward effect and degree of patients' satisfaction based on s survey.**

■ METHODS: **This retrospective study was approved by the institutional review board, and 112 patients treated for saccular UIAs were evaluated among a total of 135 patients. After informed consent was obtained, these patients were sent a questionnaire regarding treatment effectiveness, complications, and patient satisfaction. These data were collected and compared with angiographic and clinical outcome.**

■ RESULTS: **The response rate was 87.5% (98/112). Intracranial complications occurred in 10 aneurysms (10.2%): 7 ischemic and 3 hemorrhagic strokes. Other complications occurred in 30 patients (30.6%): 17 alopecia, 15 bleeding tendency, and 3 puncture-site complications. Overall, 89 (90.8%) patients reported being satisfied with their treatment. Patient satisfaction was closely correlated with clinically successful outcome of treatment.**

■ CONCLUSIONS: **Ninety percent of patients were satisfied with the results after endovascular treatment of UIAs. Endovascular coil embolization was effective and safe procedure, with high clinical success rate and degree of satisfaction.**

## INTRODUCTION

Unruptured intracranial aneurysms (UIAs) are common vascular lesions, and the prevalence of UIAs is estimated at 3.6%–6.0% in the population older than 30 years of age.[1] UIAs increasingly are being detected as imaging techniques are improved and used more frequently. For ruptured intracranial aneurysms, management and treatment options, such as craniotomy or endovascular treatment, have been well defined in several trials[2,3]; however, the best management for UIAs is currently controversial as the result of incomplete and conflicting data regarding the natural history of these lesions and the risks associated with the method of repair.

Although generally asymptomatic up to their rupture, UIAs can have nonspecific symptoms, such as frequent headache resistant to medical treatment or can present with nerve palsy or compression effects to the adjacent neurovascular structures.

Endovascular treatment of UIAs has remarkably improved during the past decades and is currently widely used.[4-8] Advancements in endovascular coiling technique have allowed more patients to be treated, particularly elderly individuals, in whom surgical clipping is considered risky.

Most researchers have focused on the anatomical (radiologic) and clinical outcome of endovascular treatment, which have generally indicated better short-term angiographic outcome and lower permanent neurologic impairment than surgical clipping. However, published evidence documenting patient satisfaction of endovascular treatment of UIAs is lacking.

Herein, our single-center experience of endovascular treatment of patients with saccular UIAs is presented. The results, safety, and efficacy were assessed and patient satisfaction evaluated after endovascular treatment of UIAs.

**Key words**
- Complications
- Endovascular coil embolization
- Questionnaire
- Satisfaction
- Unruptured intracranial aneurysms (UIAs)

**Abbreviations and Acronyms**
3D: 3-Dimensional
MCA: Middle cerebral artery
UIA: Unruptured intracranial aneurysm

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**Table 1.** Characteristics of the Patients and Aneurysms ($n$ = 98)

| Characteristics | No. of Patients |
|---|---|
| Age, years | |
| <50 | 12 (12.6%) |
| 50～70 | 64 (65.1%) |
| >70 | 22 (22.3%) |
| Mean, years | 61.3 |
| Sex | |
| Female | 77 (79.6%) |
| Male | 21 (20.4%) |
| Aneurysm size, mm | |
| <6.2 | 31 (31.6%) |
| ≥6.2 | 67 (68.4%) |
| Aneurysm neck, mm | |
| <4.2 | 27 (27.6%) |
| ≥4.2 | 71 (72.4%) |
| Dome to neck ratio | |
| <1.15 | 54 (55.1%) |
| ≥1.15 | 44 (44.9%) |
| Presentation at admission | |
| Headache | 45 (45.9%) |
| Incidental finding | 31 (31.6%) |
| Dizziness | 29 (30.0%) |
| Visual disturbance | 7 (7.1%) |
| Ptosis | 3 (3.1%) |
| Paresthesia | 3 (3.1%) |
| Memory disturbance | 1 (1.0%) |

## METHODS

### Patient Characteristics

From August 2008 to September 2012, a total of 135 UIAs were occluded with detachable coils and/or stent, balloon at our hospital. Before embolization, patients provided signed written informed consent for the treatment. The indications for endovascular coiling were largely dependent on the surgeon's discretion based on surgical difficulty causing potential complications, patient's refusal of craniotomy, elderly patients, and poor medical condition.

Patients with dissecting or fusiform aneurysms, aneurysms treated with parent artery sacrifice, aneurysms associated with brain arteriovenous malformations or tumors, and mycotic aneurysms were excluded from the study. Patients with UIA who also had a ruptured aneurysm or multiple aneurysms were excluded to avoid selection bias. This study was approved by the institutional review board.

Analysis of aneurysm morphology, including dome and neck size and aspect ratio, was performed based on the precise measurements made on 3-dimensional (3D) angiograms. Procedure-related complications, postoperative complications, immediate clinical results, latest patient clinical outcomes, and the degree of patient satisfaction were assessed using patient medical records, face-to-face or telephone interviews, and questionnaire with patients or immediate family members. Clinical follow-up more than 6 months after endovascular treatment was available for 112 patients. Each patient outcome was graded according to a modified Rankin Scale. Complications were defined as neurologic deterioration, abnormal neuroimaging findings, and undesirable events related to the procedures.

### Coiling Procedures and Supporting Techniques

Coiling of aneurysms was performed on a commercially available biplane angiographic unit equipped with an image-intensifier matrix of 1024 × 1024. Rotational angiography, followed by 3D image reconstruction by volume rendering, was performed by using the Integris 3D-RA release 3.2 software package (Philips Medical Systems, Eindhoven, the Netherlands) before the embolization procedures in all cases. Based on of the images generated with rotational acquisition, at least 2 working projections that provided the best achievable view of the aneurysm neck were defined. Antiplatelet medication including aspirin and clopidogrel was used before the endovascular treatment in all cases at least 2 days before the operation.

All aneurysms were coiled with patients under general anesthesia. Systemic heparinization was performed after placement of the arterial introducer sheath according to our embolization protocol; 3000 IU of heparin was administered as an intravenous bolus injection, followed by an additional 1000 IU per hour. Heparin was discontinued after embolization in most patients but not reversed.

Each aneurysm embolization was performed using detachable coils. The aim of coiling was to pack the aneurysm as densely as possible without compromising the lumen of the parent artery and branch. Aneurysms were occluded with Guglielmi detachable coils, Axium coils (EV3, Irvine, California, USA), Deltapaq coils (Codman, Raynham, Massachusetts, USA), or Target coils (Stryker, Fremont, California, USA).

Hemostasis was achieved using the Angio-Seal (St. Jude Medical, St. Paul, Minnesota, USA) vascular closure device after removing the femoral sheath catheter in all cases by applying a sandbag for 6 hours. Neck remodeling techniques (stent-assisted or balloon-assisted) were used when necessary for aneurysms with unfavorable angioarchitecture instead of the simple technique. Either the Enterprise stent (Cordis Neurovascular, Miami, Florida, USA) or a Neuroform stent (Boston Scientific/Target, Fremont, California, USA) was placed within the afferent to efferent vessel's lumen before coiling. After the procedure, the patient was sent to the intensive care unit overnight while maintaining activated clotting time of 150–200 compared with normal control patients.

### Angiographic Results and Follow-Up

In all cases, aneurysmal sac and neck were packed until no contrast filling of the aneurysm sac was confirmed based on angiography. Patients were scheduled for a follow-up visit and a plain radiographic examination in an outpatient clinic usually within 3 months after coiling. Our routine surveillance protocol is

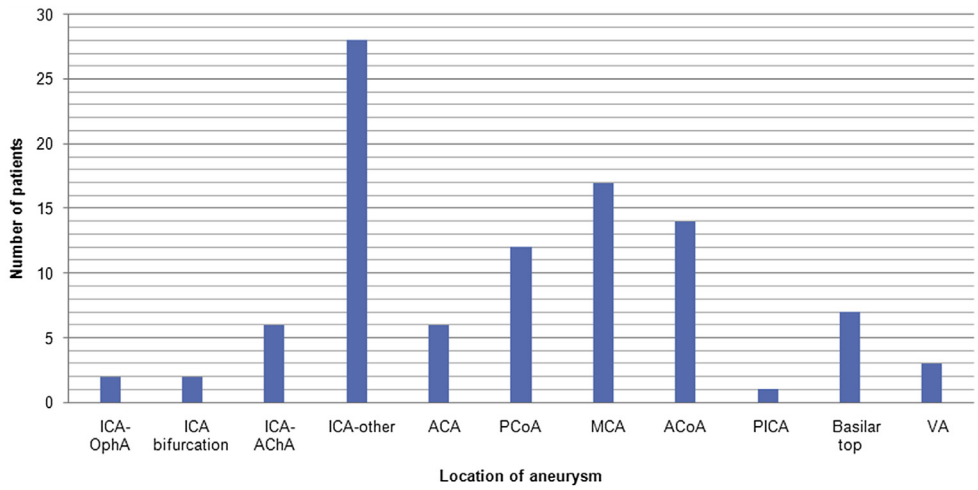


**Figure 1.** Bar graph showing location of aneurysms. ICA, internal carotid artery; AChA, anterior choroidal artery; ACA, anterior cerebral artery; PCoA, posterior communicating artery; MCA, middle cerebral artery; ACoA, anterior communicating artery; PICA, posterior inferior cerebellar artery; VA, vertebral artery.

to perform plain sellar radiography at 3 months, magnetic resonance angiography at 6 months, and conventional angiography 1 year after coiling. Neurologic status and systemic physical review were performed at every visit.

## Antiplatelet Medication

The antiplatelet preparation prescribed was aspirin 100 mg/day and clopidogrel 75 mg/day orally for at least 5 days before coiling. If these daily regimens were not followed, aspirin 400 mg and clopidogrel 800 mg were given in loading doses. Patients treated with embolization were generally given aspirin 100 mg/day and clopidogrel 75 mg/day for 3–6 months.

## Questionnaire

After approval from the institutional review board, a single questionnaire was sent to the patients in February 2013 who agreed to take the survey. Responses were received over a period of 4 weeks. The questionnaire, translated into English, is shown in the **Appendix**.

The questionnaire included questions regarding symptoms before and after treatment, and the occurrence of any

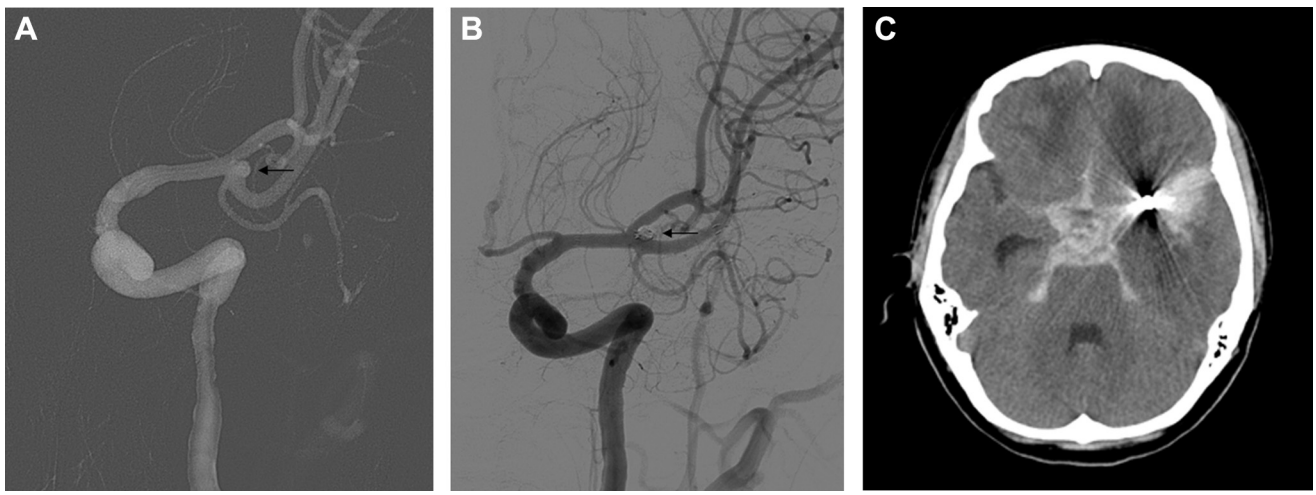


**Figure 2.** A 46-year-old female patient who presented with mild headache. (**A**) Left internal carotid angiogram shows an unruptured saccular aneurysm (*arrow*) of the left middle cerebral artery bifurcation. (**B**) Stent-assisted coil embolization of the unruptured aneurysm due to wide neck. The arrow denotes aneurysm sac after coil embolization. (**C**) Computed tomography of the brain after embolization showing diffuse subarachnoid hemorrhage with focal parenchymal hematoma.

**Table 2.** Comparison Between No Stroke and Stroke Groups*

| Parameter | No Stroke Group | Stroke Group | *P* Value |
|---|---|---|---|
| No. patients | 88 | 10 | |
| Age, years | 61.3 | 62.0 | 0.869 |
| Sex | | | 0.113 |
| Male | 19 | 2 | |
| Female | 69 | 8 | |
| Dome size | 7.35 ± 2.57 | 9.09 ± 6.48 | 0.763 |
| Neck size | 4.97 ± 1.88 | 6.98 ± 5.19 | 0.527 |
| Dome/neck ratio | 1.51 ± 0.25 | 1.33 ± 0.13 | 0.573 |
| Location of aneurysm | | | 0.167 |
| ICA-OphA | 2 | 0 | |
| ICA bifurcation | 2 | 0 | |
| ICA-AChA | 5 | 1 | |
| ICA-other | 27 | 1 | |
| ACA | 6 | 0 | |
| PCoA | 10 | 2 | |
| MCA | 14 | 3 | |
| ACoA | 12 | 2 | |
| PICA | 1 | 0 | |
| Basilar tip | 6 | 1 | |
| Vertebral artery | 3 | 0 | |

ICA-OphA, ophthalmic segment of internal carotid artery; ICA, internal carotid artery; AchA; anterior choroidal artery; ACA, anterior cerebral artery; PCoA, posterior communicating artery; MCA, middle cerebral artery; ACoA, anterior communicating artery; PICA, posterior inferior cerebellar artery.
*Stoke: thromboembolic or hemorrhagic manifestation on postoperative images.

complications related to treatment or antiplatelet medication. Patients could also fill in additional symptoms. Finally, patients were asked regarding satisfaction with their treatment graded on a 5-point scale: score 1, very satisfied; score 2, satisfied; score 3, common; score 4, dissatisfied; and score 5, very dissatisfied.

### Statistical Analysis

Qualitative data are expressed as numbers and/or percentages. Statistical analysis was performed using the Fisher exact test/Wilcoxon rank sum test with commercially available statistic program SPSS 14.0 (SPSS Inc., Chicago, Illinois, USA). Differences were considered statistically significant at $P < 0.01$.

## RESULTS

Of the 135 patients treated for UIAs, 23 patients were excluded based on the inclusion criteria; 18 due to anatomic causes and 5 for refusing to take the survey. In addition, 112 patients were sent a questionnaire regarding treatment effectiveness and patient satisfaction. After informed consent was obtained, a questionnaire was returned over a period of 4 weeks. Subsequently, responses were obtained from 98 of 112 (87.5%) patients.

Clinical presentation at admission was mostly headache (45 patients, 45.9%), incidental findings (31 patients, 31.6%), and dizziness (29 patients, 30.0%). The study included 77 females (78.6%) and 21 males (21.4%) with a mean age of 61.3 years (Table 1).

### Location and Size of Aneurysms

Eighty-seven of 98 aneurysms (88.8%) were located in the anterior circulation, and 11 (11.2%) were in the posterior circulation. Frequent locations included the paraclinoid internal carotid artery, middle cerebral artery (MCA), anterior communicating artery, and posterior communicating artery (Figure 1). The size of aneurysms ranged from 3.0–28 mm in maximum diameter, with a median size of 6.2 mm (mean 7.0 mm). Aneurysm necks ranged from 2.0 to 22 mm, with a median size of 4.2 mm (mean 4.8 mm). The dome-to-neck ratio (aspect ratio) ranged from 0.67 to 2, with a mean of 1.15 (Table 1).

### Intracranial Complications

Intracranial complications (stroke) occurred in 10 aneurysms (11.2%): 7 ischemic (thromboembolic) and 3 hemorrhagic (intraprocedural rupture). Thromboembolic complications occurred in 7 (7.1%) patients; 1 resulted in a persistent neurologic deficit, which

**Table 3.** Complications Based on Available Endovascular Techniques

| | Simple | Stent Assisted | Balloon Assisted | *P* Value |
|---|---|---|---|---|
| No. of patients | 57 | 39 | 2 | |
| Complication | | | | |
| – | 42 | 21 | 2 | 0.074 |
| + | 15 | 18 | 0 | |
| Stroke | | | | |
| – | 51 | 35 | 2 | 1.000 |
| + | 6 | 4 | 0 | |
| Alopecia | | | | |
| – | 46 | 33 | 2 | 0.855 |
| + | 11 | 6 | 0 | |
| Inguinal hematoma | | | | |
| – | 55 | 38 | 2 | 1.000 |
| + | 2 | 1 | 0 | |
| Bleeding tendency | | | | |
| – | 53 | 28 | 2 | 0.019 |
| + | 4 | 11 | 0 | |

was in accordance with the consequences of a left cerebral infarct secondary to MCA branch occlusion, 2 resulted in transient neurologic deficits that resolved within 24 hours postoperatively, and 4 were asymptomatic. In patients who showed partial filling defect in branch during or at completion of procedure, intra-arterial rescue with tirofiban was performed, and an intravenous anticoagulation with heparin was sustained for 24 hours after intra-arterial trial.

In 3 patients with rupture, 1 occurred during micro-guidewire navigation with resultant diffuse subarachnoid hemorrhage and focal parenchymal hematoma, which was managed by swift coil packing and stent deployment. The patient died from direct effect of hemorrhage (Figure 2). In the other 2 patients, rupture occurred during the second and final coil packing and they were conservatively managed uneventfully.

In the 10 cases with complications, aneurysm locations included the MCA in 3 patients, anterior communicating artery in 2 patients, internal carotid artery in 2 patients, posterior communicating artery in 2 patients, and the basilar tip in 1 patient (Table 2). Regarding complications versus aneurysm location and treatment technique, a valid statistical analysis was not possible due to the small number of events (Table 3).

### Other Complications

Other complications included alopecia, bleeding tendency, and puncture-site hematoma. Overall, 30 of 98 (30.6%) patients reported complications after treatment. In 17 (17.3%) patients, alopecia had occurred mainly in the most dependent portion (i.e., occipital) immediately after the procedure in 6 patients, and 2–4 weeks after the procedure in 11 patients. In all patients, no specific additional treatment for these complications was necessary and hair growth was observed after 6 months.

Fifteen (15.3%) patients had multiple bruising on extremities or gingival bleeding; however, additional treatment for these symptoms was not required. Most symptoms related to antiplatelet medication were halted after drug discontinuation. One patient suffered acute interhemispheric subdural hematoma in a vehicle collision, and medication had to be stopped with no consequence. Medication was temporarily stopped in 2 patients due to tooth extraction and endoscopic resection for gastric cancer. Each patient resumed prescription thereafter without any incidents.

Puncture-site complication occurred in 3 (3.1%) patients after treatment. One elderly female patient suffered retroperitoneal hematoma that progressed to renal failure and shock (Figure 3). Another 2 patients reported groin swelling up to 1 month postoperatively, which subsided spontaneously. For each complication, the complication rate was not significantly different based on the relevant endovascular techniques (Table 3).

### Angiographic Outcomes

Follow-up imaging evaluations with plain radiography, magnetic resonance angiography, and/or conventional angiography were performed in 98 patients for at least 6 months after embolization. Five of the 98 (5.1%) aneurysms showed recurrence. Of these lesions, 3 with small neck recurrences were not candidates for a second treatment because the recurrences appeared too small for further coil placement; 2 were posterior communicating arteries and 1 was the ophthalmic artery. Two aneurysms constituting basilar tip and anterior communicating artery required repeat coil packing at 1 year and 3 years after first coiling; however, the patients were asymptomatic. Endovascular coil embolization was well established as a major tool for treating both anterior and posterior circulation aneurysms.

### Clinical Outcomes and Patient Satisfaction

Clinical follow-up was available in all 98 patients. Clinical status was defined using the modified Rankin Scale. Clinical follow-up periods varied from 6 months to 5 years with a mean of 25.5 ± 4.2 months.

One patient died from intraoperative rupture; a direct complication after endovascular treatment. In addition, 2 patients died due to indirect complications. One patient died from an acute myocardial infarction, and another patient died from aspiration pneumonia. The other 95 patients resumed their previous daily activities (Table 4).

Eight-nine (90.8%) patients reported being satisfied with the treatment and would choose to undergo treatment again if faced with the choice. Clinical outcome and patient satisfaction were significantly different based on each complication ($P < 0.01$). Good clinical success and patient satisfaction were closely related (Table 5 and Figure 4).

## DISCUSSION

Increased sensitivity and the greater availability of neuroimaging techniques have resulted in frequent detection of UIAs. Because aneurysmal subarachnoid hemorrhage frequently causes devastating neurologic injury, prevention has been advocated as the most effective strategy with the intention of reducing mortality rates. Although the risk of aneurysmal rupture and treatment

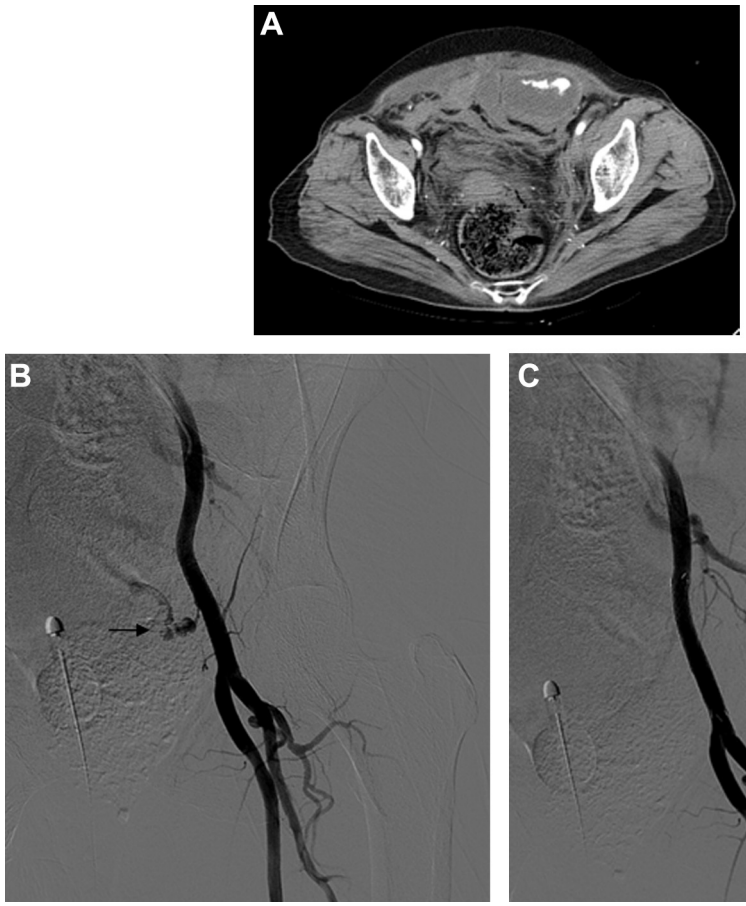


**Figure. 3.** A 70-year-old female patient who underwent endovascular coil embolization for an anterior communicating artery unruptured aneurysm. One day after endovascular embolization, patient's hemoglobin decreased from 11.3 g/dL to 3.9 g/dL. (**A**) Enhanced computed tomography of the abdomen scan showing extensive hemoperitoneum with contrast extravasation. (**B**) Left iliac arteriogram showing extravasation of the contrast (*arrow*) at the distal portion. (**C**) Left iliac arteriogram after stent graft insertion showing complete occlusion of the bleeding site.

morbidity and mortality has been extensively investigated, current evidence does not conclusively support a standard treatment strategy regarding UIAs and in particular, the size at which an aneurysm becomes dangerous remains uncertain.[9,10] All current treatments have potential risks, and recommendations for treatment versus observation are often difficult and controversial.

**Table 4.** Postoperative Clinical Results Based on the mRS

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 (Death) | Total |
|---|---|---|---|---|---|---|---|---|
| 0 | **29** | 2 | 0 | 0 | 0 | 0 | 0 | 31 |
| 1 | 36 | **23** | 0 | 0 | 0 | 0 | 0 | 59 |
| 2 | 0 | 2 | **2** | 0 | 0 | 0 | 2 | 6 |
| 3 | 0 | 0 | 0 | **0** | 1 | 0 | 1 | 2 |
| Total | 65 | 27 | 2 | 0 | 1 | 0 | 3 | 98 |

Comparison between preoperative mRS (horizontal lines) and 6-month postoperative mRS (vertical columns). Values in bold include patients who were considered clinically stable (no morbidity).

Values located below the values in bold correspond to patients clinically improved 6 months after treatment.

mRS, modified Rankin Scale.

**Table 5.** Comparison Between Satisfied and Dissatisfied Groups

| Parameter | Satisfied Group | Dissatisfied Group | *P* Value |
|---|---|---|---|
| No. of patients | 89 | 9 | |
| Age, years | 61.5 | 60.3 | 0.869 |
| Sex | | | |
| Male | 21 | 0 | 0.113 |
| Female | 68 | 9 | |
| mRS | | | |
| 0–2 | 88 | 4 | 0.000 |
| 3–6 | 1 | 5 | |
| Complication | | | |
| – | 65 | 0 | 0.000 |
| + | 24 | 9 | |
| Stroke | | | |
| – | 85 | 3 | 0.000 |
| + | 4 | 6 | |
| Alopecia | | | |
| – | 76 | 5 | 0.046 |
| + | 13 | 4 | |
| Inguinal hematoma | | | |
| – | 87 | 8 | 0.253 |
| + | 2 | 1 | |
| Bleeding tendency | | | |
| – | 79 | 4 | 0.004 |
| + | 10 | 5 | |

mRS, modified Rankin score.

## Intracranial Complications

In the present study, endovascular results of 98 UIAs were reported. There were a total of 10 procedure-related complications (10.1%); 7 ischemic and 3 hemorrhagic. In the Analysis of Treatment by Endovascular approach of Nonruptured Aneurysms (ATENA) study of a large number of patients with 739 UIAs and 700 procedures conducted at 27 Canadian and French neurointerventional centers, the rates of thromboembolic events and intraoperative aneurysmal rupture were 7.1% and 2.6%, respectively.[11]

Standhardt et al.[12] reported 10.9% of thromboembolic events in 173 patients with UIAs treated using endovascular therapy. Five patients (3%) in their study had strokes, including major and minor deficits (0.5% and 2.5%, respectively).

In the ATENA study, intraoperative aneurysmal rupture was observed in 18 (2.6%) patients. Among the 18 patients, 5 manifested a permanent clinical aggravation and 3 patients died.[11] In the current study, intraoperative aneurysmal rupture occurred in 3 aneurysms (3.0%). Two of the 3 patients who had an intraoperative aneurysmal rupture were discharged without any neurologic deficits.

In addition, factors affecting complications during the endovascular treatment of UIAs were analyzed in the ATENA study.[11] The risk of thromboembolic complications was low in the small UIAs (1–6 mm) and the occurrence of thromboembolic complications was not significant regarding location, aneurysm size, or embolization technique. In another study, Oishi et al.[13] reported the aspect ratio of <1.5 was a significant risk factor for thromboembolic complications. The risk of intraoperative aneurysmal rupture was significantly greater in smaller aneurysms in previous studies.[11,14-16]

Interestingly, occurrence of thromboembolic complications or intraoperative rupture was not significantly different based on the location, size of aneurysms, aspect ratio, or endovascular techniques in the present study.

## Extracranial Complications

All the patients in this study were administered dual antiplatelet medication including aspirin and clopidogrel. Possible side effects of antiplatelet agents include nausea, vomiting, diarrhea, skin rash, bruising, alopecia, irritation of the stomach lining, and bleeding from the digestive system and other internal organs. In the present study, the focus was on bleeding tendency and alopecia. Alopecia occurred in 18 (17.4%) patients and gingival bleeding in 10 (9.7%) patients; however, none of the patients required additional treatment for these symptoms. Most symptoms related to antiplatelet medication disappeared after drug discontinuation.

Not only antiplatelet medication but also prolonged exposure to radiation can cause alopecia. Alopecia after head and neck radiotherapy has been extensively reported in the literature. Prolonged fluoroscopic imaging during endovascular procedures may cause serious radiation injuries to the skin, such as dermatitis or alopecia. In addition, radiation can cause some cancers in humans. In this study, the dose of radiation during the endovascular treatment was not estimated, however, prolonged exposure to radiation may have a negative effect on patients undergoing endovascular treatment.

Yamada et al.[17] reported the efficacy of antiplatelet medication for lowering the thromboembolic complication rate. Despite some side effects such as alopecia or bleeding tendency, antiplatelet medication must be given to patients who undergo endovascular treatment due to the efficacy of medication lowering the thromboembolic complication rate.

There were some complaints regarding side effects of antiplatelet medication. Some patients were not aware of the possibility of the side effects such as alopecia or bleeding tendency. Physicians should provide sufficient information to patients regarding the side effects of antiplatelet medication.

In several studies, the use of the Angio-Seal in arterial punctures has been described.[18-23] Mukhopadhyay et al.[24] described a complication rate of 9.4% (4.7% hematomas and 4.7% ischemia) in 21 patients undergoing arterial puncture closure with the Angio-Seal device. Compared with previous studies of complications, the results from the present study showed a lower complication rate (3.1%). However, an inadvertent puncture of the external iliac artery resulted in retroperitoneal hematoma despite Angio-Seal implementation and sand bag application. When this occurs, compression with a sand bag is not easy and, therefore,

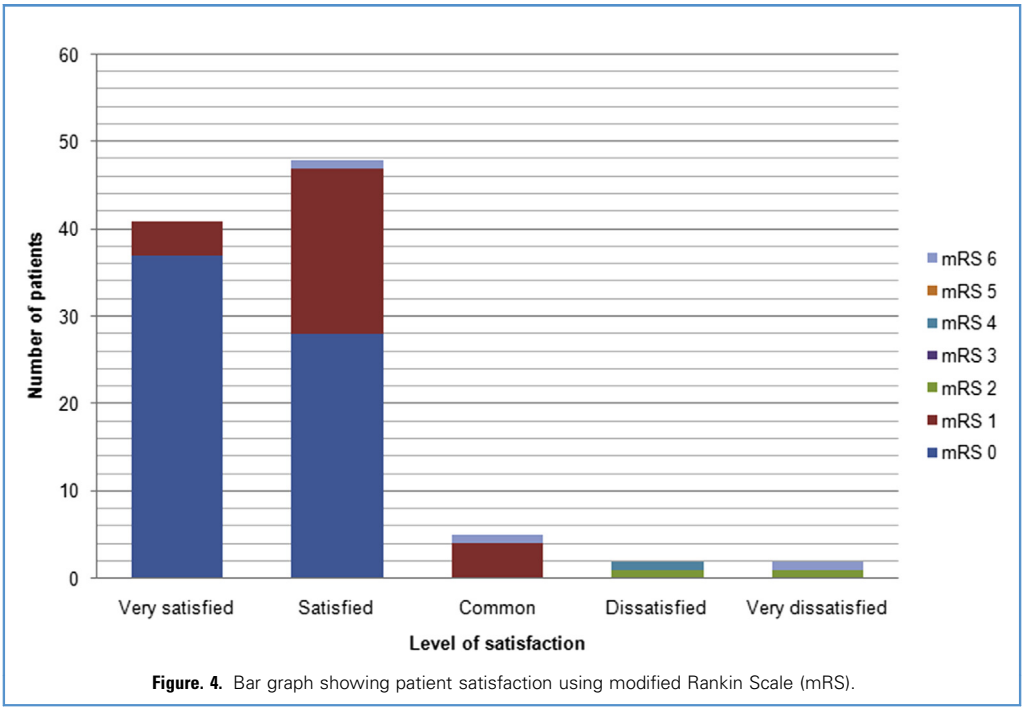


**Figure. 4.** Bar graph showing patient satisfaction using modified Rankin Scale (mRS).

detecting the retroperitoneal hematoma is very difficult because of the deeper retroperitoneal location of this vessel. A retroperitoneal hematoma may be associated with femoral artery puncture irrespective of whether a closure device is used after the intervention[25] and can be caused by an inadvertent puncture of the posterior wall of the femoral or iliac artery during cannulation. Multiple attempts to puncture the femoral artery or puncture points high above the inguinal ligament of the femoral artery may result in occult retroperitoneal bleeding.[26,27] An advertent puncture of the common femoral artery is of utmost importance, and if found during intervention, another vascular closure device should be used instead of Angio-Seal. Surgeons should be aware of the occurrence of retroperitoneal hematoma as a consequence of interventional procedures such as femoral arterial puncture.

## Patient Satisfaction

In this study, the results after endovascular treatment of UIAs were evaluated with focus on patient experience regarding clinical effects and overall patient satisfaction with the treatment. Clinical success reinforced by angiography was reported by 93 of 98 (94.9%) patients with durable long-term results in most patients, and clinical success, as reported by the patient, was strongly related to patient satisfaction.

The results from this study demonstrated that endovascular coiling in patients with UIAs is safe and effective. Outcomes were excellent in most cases (94.9%). Procedure-related events occurred in some patients (10.1%) and the incidence of permanent deficit was 2.0%; however, these 2 events occurred earlier in the study period. This outcome is more favorable than in previous studies. However, some complicated cases were excluded due to refusal to take the survey; therefore, the practical incidence of permanent complications was not known.

The questionnaire was sent to 112 patients who agreed to take the survey. However, 14 patients did not return the questionnaire. Possibly, in complicated cases or dissatisfied patients, the patient or immediate family members agreed to take the survey but did not return the questionnaire. Therefore, the results from this study may be more favorable and overestimated than the actual clinical outcome.

The current study differs from other studies because the focus was on whether the patient was satisfied with treatment results. Articles documenting the patient satisfaction after endovascular treatment are lacking, thus, the results from this study could not be compared with other studies. However, 89 of 98 (90.8%) patients in this study reported being satisfied with the treatment result and would choose to undergo treatment again if faced with the choice. Two patients were dissatisfied with their treatment due to thromboembolic complications. In addition, another 2 patients were dissatisfied with their treatment due to insufficient explanation after treatment. We believe that patient satisfaction is the most relevant outcome for UIAs, and minor complications including alopecia, bruising, and puncture-site problems would not be an obstacle to undergoing intervention.

## Limitations and Future Perspectives

The present study had several limitations and strengths. First, this was a retrospective study; therefore, selection bias was inevitable, and some complicated cases were excluded because patients or immediate family members disagreed to the survey-based study. Therefore, the results from this study may be more favorable than the actual clinical outcomes. Second, due to the small number of

cases in the study, the findings may not be generalized to a wider group of endovascular treatment patients.

Therefore, a prospective, multicenter, and well-stratified trial with a longer follow-up period is needed for confirmation of the effects of endovascular treatment of UIAs and patient satisfaction, including natural history of treated UIAs in terms of endurability, future cancerogenicity related to radiation, and safe margin of dual anti-platelet coverage.

Notwithstanding the aforementioned limitations, in the present study, most of the patients treated for UIAs in a single-center were surveyed except for 5 patients who refused to take the survey. More concise and thorough review was possible in this small-volume clinical practice institution. The results from this study reflect more detailed patient information and are relevant to practical situations.

## CONCLUSIONS

The potential rupture risk of UIAs and the benefits of prophylactic treatment remain debatable. In the present study, the procedural safety of the endovascular coiling of unruptured saccular aneurysms was assessed and results showed endovascular treatment of UIAs was successfully performed without inducing neurologic deficits in most patients.

Providing a conclusion regarding treatment guidelines for UIAs was not the focus of this study but instead to help guide future recommendations by presenting a more generalized estimate of endovascular treatment risk than is currently available. In addition, determining patient satisfaction regarding endovascular treatment of UIAs was important. Further prospective randomized studies should be performed to determine patient satisfaction with UIA endovascular treatment.

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## APPENDIX

Q1. Did you have one or more of the following symptoms before endovascular treatment?

① Headache

② Dizziness

③ Visual discomfort

④ Seizure

⑤ Diplopia

⑥ Ptosis

⑦ Other

⑧ No symptoms

Q2. Did you still have any symptoms after endovascular treatment?

① No

② Yes

Q3. Did you have any symptoms of stroke (infarction or hemorrhage) after endovascular treatment?

① Yes

② No

Q4. If you had any symptoms of stroke, what was the symptom?

① No symptom

② Weakness

③ Dysphasia

④ Paresthesia or pain

⑤ Visual discomfort

⑥ Other

Q5. Did you have alopecia after endovascular treatment? (if no, go to No. 8)

① No

② Yes

Q6. If you had alopecia, how long the symptom continued?

① ≤6 months

② >6 months

Q7. How you treated for alopecia?

① Observation

② Dermatology

③ Other

Q8. Did you have inguinal hematoma or swelling after endovascular treatment? (if no, go to No. 10)

① No

② Yes

Q9. If you had inguinal hematoma or edema, how long the symptom continued?

① <1 month

② ≤3 months

③ >3 months

Q10. If you have heard about recurrence of aneurysm or increase of the size after treatment? If yes, how long after the treatment?

① No

② Yes ( )

Q11. How long did you take antiplatelet medication after the treatment?

Q12. During the antiplatelet medication, did you have any symptoms like gingival bleeding or any other bleeding tendency? If yes, what was the detailed situation?

① No

② Yes ( )

Q13. What is the patient's functional outcome now?

① No symptoms at all

② No significant disability despite symptoms; able to carry out all usual duties and activities

③ Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance

④ Moderate disability; requiring some help, but able to walk without assistance

⑤ Moderate severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance

⑥ Severe disability; bedridden, incontinent and requiring constant nursing care and attention

⑦ Dead

Q14. Were you generally satisfied with the effects of the treatment?

① Very satisfied

② Satisfied

③ Common

④ Dissatisfied

⑤ Very dissatisfied

Q15. If you or your friend have another unruptured intracranial aneurysm, will you have endovascular treatment again?

① Yes

② No

Q16. Any words to physicians?