Cureus
Part of SPRINGER NATURE

Open Access Original Article

Stratified Outpatient Management and Radiological Follow-Up After Endovascular Treatment for Unruptured Intracranial Aneurysms

Review began 09/19/2026
Review ended 10/15/2026
Published 10/24/2026

© **Copyright** 2026
Matsubara et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.118526

Noriaki Matsubara [1], Kosumo Noda [1], Hiroaki Nomura [1], Masanori Gomi [1], Soichiro Yasuda [1], Shota Yoshitomi [1], Shiro Nagasawa [1], Eimei Tsuda [1]

1. Department of Neurosurgery, Soseikai General Hospital, Kyoto, JPN

Corresponding author: Noriaki Matsubara, mnoriaki0817@gmail.com

Abstract

Introduction

This study aimed to evaluate post-procedural clinical courses and radiological outcomes after endovascular treatment for unruptured intracranial aneurysms using a multi-institutional dataset and explore a preliminary, risk-stratified outpatient follow-up framework.

Materials and methods

We retrospectively reviewed 79 endovascular treatment cases across 77 patients for unruptured intracranial aneurysms between 2018 and 2025 at Soseikai General Hospital (Kyoto, Japan) and affiliated institutions. Outpatient visit timing/content, adverse events, and follow-up MRI findings were analyzed.

Results

Treatment modalities included coil embolization (65 cases: 57 non-stent and eight stent-assisted) and flow diverter (FD) placement (14 cases). Regarding coil-treated cases, stent-assisted coiling required more frequent post-procedural antiplatelet therapy (APT) and close monitoring than non-stent coiling, whereas non-stent coiling without post-discharge APT was associated with no early hemorrhagic events. Seven patients required unscheduled visits before the first scheduled appointment. In the coil embolization cases, unscheduled visits were related to an access site complication (n = 1), cerebral ischemic symptoms (n = 1), and headache and dizziness (n = 1) in the non-stent coiling group; headache (n = 1) was reported in the stent-assisted coiling group. In the FD group, patients presented with intracranial hemorrhage (n = 1), worsened visual function (n = 1), and headache (n = 1). At the first scheduled visit (n = 72; mean: 34.6 ± 17.5 days, median: 33.0 days), clinical management primarily focused on APT adjustment. One patient treated with an FD required emergency readmission during this visit due to exacerbation of mass effect. When evaluated according to postoperative antithrombotic status, within three months post-procedure, any hemorrhagic events occurred in 13.6% of the discharge APT group (n = 59), whereas none occurred in the non-APT group (n = 20), although ischemic symptoms occurred in 10.0% (two of 20 cases). While initial follow-up MRI (n = 66; mean: 90.2 ± 33.0 days, median: 96.0 days) showed no radiological evidence of aneurysm recurrence, it detected suspected foreign-body granulomas (two cases) and moderate parent artery stenosis (one case). The second MRI (n = 57; mean: 317.1 ± 110.0 days, median: 305.0 days) revealed delayed recurrence in 3.5% (two of 57 cases). Over the entire follow-up, no rupture occurred; recurrence was observed in three cases (5.1% of 59 cases with long-term follow-up MRI), and one case (1.7%; 1/59) required retreatment, corresponding to 3.8% (3/79) and 1.3% (1/79) of the total cohort.

Conclusions

Post-procedural management may be stratified according to treatment modality and post-discharge APT. While patients treated with FDs or stent-assisted coil embolization require intensive clinical monitoring to detect early complications, our findings suggest that the initial scheduled outpatient visit and MRI might be safely deferred until approximately three months after treatment in carefully selected low-risk patients undergoing non-stent coil embolization without post-discharge APT. Individualized early visits may still be offered to address patient anxiety. This risk-stratified approach represents a preliminary framework for optimizing outpatient follow-up schedules.

Categories: Radiology, Neurosurgery
Keywords: antiplatelet therapy, coil embolization, endovascular treatment, flow diverter treatment, outpatient management, radiological follow-up, unruptured intracranial aneurysm

Introduction

Endovascular therapies, including coil embolization and flow diverter (FD) placement, are established, minimally invasive standard treatments for unruptured intracranial aneurysms. However, regular long-term radiological follow-up is an integral component for detecting post-procedural aneurysm recurrence and related complications [1]. Furthermore, with the increasing adoption of stent-assisted coil embolization and modern FDs (e.g., Pipeline Embolization Device, Flow Re-Direction Endoluminal Device (FRED), and Surpass), the management of post-procedural antiplatelet therapy (APT) has become increasingly critical [2]. Despite its clinical significance, the optimal scheduling of outpatient visits and follow-up imaging varies across institutions and is often determined based on institutional protocol or individual experience rather than standardized evidence [3].

In this study, we retrospectively analyzed post-procedural outpatient follow-up and radiological outcomes (primarily via MRI) after endovascular treatment for unruptured intracranial aneurysms across a consolidated multi-institutional cohort. Specifically, the primary objective of this study was to evaluate post-procedural clinical courses (including early complications and unscheduled visits) and long-term radiological outcomes across different treatment modalities (non-stent coiling, stent-assisted coiling, and FD placement). As a secondary objective, we aimed to explore a preliminary, risk-stratified framework for outpatient follow-up timing and imaging schedules to provide initial insights into safe, modality-tailored post-procedural care.

Materials And Methods

Patient selection and criteria

We retrospectively reviewed consecutive patients with unruptured intracranial aneurysms who underwent endovascular treatment at Soseikai General Hospital (Kyoto, Japan) and affiliated institutions between 2018 and 2025. The primary unit of analysis was the treatment case. A total of 79 treatment cases across 77 patients were initially included in this study. Two patients each underwent two separate endovascular procedures for distinct aneurysms, contributing two treatment cases each; these repeated procedures were analyzed as independent treatment cases given their distinct lesion characteristics and follow-up timelines. The inclusion criteria were patients of any age with unruptured intracranial aneurysms or previously ruptured aneurysms followed up beyond three months after onset, located in either the anterior or posterior circulation, and treated with endovascular therapies, including simple coiling, balloon- or stent-assisted coiling, or FD placement. The exclusion criteria were patients with acute ruptured aneurysms, patients who did not attend any post-procedural outpatient visits at our institutions (e.g., those transferred to external hospitals for follow-up just after treatment), and patients with missing clinical or imaging follow-up data. All eligible consecutive cases meeting the criteria were included without an a priori sample size calculation.

Follow-up protocols and clinical definitions

Radiological follow-up was routinely performed using MRI, with evaluation focused on MRA and its source images. Imaging was conducted using standard clinical scanners without uniform field strength restriction (utilizing both 1.5T and 3.0T systems). Aneurysm occlusion status was evaluated based on the Raymond-Roy occlusion classification for coil embolization and the O'Kelly-Marotta scale for FD placement. Post-procedural antiplatelet therapy was managed according to treatment modality and institutional protocols. Dual antiplatelet therapy (DAPT) was required for all patients undergoing stent-assisted coiling or FD placement. For patients treated without stent deployment (e.g., simple coiling or balloon-assisted coiling), the administration and duration of APT were determined at the discretion of the individual operator based on thrombotic risk and aneurysm characteristics. Adverse events were defined as procedure- or medication-related events, including neurological deficits, ischemic or hemorrhagic complications, and antiplatelet-related bleeding. Major aneurysm recurrence was defined as recanalization requiring retreatment or progressive filling of the aneurysm sac on follow-up imaging.

Data collection and outcomes

The evaluated parameters included the specific endovascular technique performed (simple coiling, balloon- or stent-assisted coiling, or FD placement), the timing and clinical management of post-discharge outpatient visits (particularly APT adjustments), the incidence and causes of unscheduled visits, the timing and findings of post-procedural radiological follow-up (primarily via MRI), and the occurrence of hemorrhagic or ischemic adverse events during the follow-up period. Potential confounders, such as variations in aneurysm size, location, and specific APT regimens, were qualitatively assessed alongside clinical outcomes.

Statistical analysis

Only descriptive statistics were performed in this study, and no inferential hypothesis testing or comparative analyses among treatment groups were conducted. Continuous variables, including the elapsed days post-procedure for clinical visits and imaging, were summarized using descriptive statistics, including mean, standard deviation (SD), median, interquartile range (IQR), and range (minimum-maximum). Categorical variables were presented as counts and percentages. All statistical summaries were computed

using Python (version 3.10; Python Software Foundation).

Ethical considerations

This study was approved by the Institutional Review Board of Soseikai General Hospital (approval number: RIN R8-24), which waived informed consent based on the retrospective design and an opt-out protocol with data anonymization.

Results

Treatment modalities, initial embolization status, and discharge medications

Of the 79 cases evaluated, treatments were categorized into three main modalities: non-stent coil embolization (n = 57, 72.2%; including simple, balloon-assisted, and double-catheter techniques), stent-assisted coil embolization (n = 8, 10.1%), and FD placement (n = 14, 17.7%, all for internal carotid artery aneurysms). Overall, coil-based embolization accounted for 65 cases (82.3%), comprising the 57 non-stent and eight stent-assisted procedures.

Descriptively, aneurysm size differed among the treatment groups. Aneurysms treated with FD had a larger mean size (mean size: 11.2 ± 4.4 mm) than those in the stent-assisted coiling (9.2 ± 4.6 mm) and non-stent coiling groups (6.0 ± 2.4 mm). Large aneurysms (≥ 10 mm) were observed in 57.1% (8/14) of the FD group, compared to 25.0% (2/8) in the stent-assisted coiling group and 3.5% (2/57) in the non-stent coiling group. Subgroup comparisons were descriptive without formal hypothesis testing. Combined coil-based treatments (n = 65) achieved sufficient embolization in 54 cases (83.1%).

Regarding antithrombotic medication at discharge, DAPT was prescribed in all 14 FD cases (100.0%) and eight stent-assisted coiling cases (100%), including one patient in the stent-assisted group receiving DAPT plus a direct oral anticoagulant (DOAC). Conversely, in the non-stent coiling group, single antiplatelet therapy was utilized in 23 cases (40.4%), no antithrombotic therapy in 20 cases (35.1%), DAPT in 12 cases (21.1%), and DOAC alone in two cases (3.5%). Baseline patient characteristics, aneurysm features, treatment modalities, and discharge antithrombotic regimens are summarized in Table *1*.

Parameter	Overall (n = 79)	Non-stent coil embolization group (simple, double-catheter, balloon-assisted) (n = 57)	Stent-assisted coil embolization group (n = 8)	Flow diverter group (n = 14)
Patient demographics				
Age (years), mean ± SD	66.1 ± 12.3	66.5 ± 12.5	66.9 ± 11.7	63.9 ± 12.7
Sex (female), n (%)	61 (77.2%)	40 (70.2%)	7 (87.5%)	14 (100.0%)
Aneurysm characteristics				
Aneurysm size (mm), mean ± SD	7.2 ± 3.8	6.0 ± 2.4	9.2 ± 4.6	11.2 ± 4.4
Large aneurysm (≥10 mm), n (%)	12 (15.2%)	2 (3.5%)	2 (25.0%)	8 (57.1%)
Location, n (%)				
Internal carotid artery (C2-C4)	35 (44.3%)	18 (31.6%)	3 (37.5%)	14 (100.0%)
Internal carotid artery (PcomA, AchoA)	11 (13.9%)	10 (17.5%)	1 (12.5%)	0 (0.0%)
Anterior communicating artery	19 (24.1%)	18 (31.6%)	1 (12.5%)	0 (0.0%)
Middle cerebral artery	7 (8.9%)	6 (10.5%)	1 (12.5%)	0 (0.0%)
Vertebrobasilar system / other	7 (8.9%)	5 (8.8%)	2 (25.0%)	0 (0.0%)

Immediate occlusion status, n (%)				
Complete occlusion	14 (17.7%)	12 (21.1%)	2 (25.0%)	0 (0.0%)
Neck remnant	40 (50.6%)	36 (63.2%)	4 (50.0%)	0 (0.0%)
Body filling	11 (13.9%)	9 (15.8%)	2 (25.0%)	0 (0.0%)
Residual flow (expected for FD)	14 (17.7%)	0 (0.0%)	0 (0.0%)	14 (100.0%)
Antithrombotic medication at discharge, n (%)				
DAPT (dual antiplatelet therapy)	33 (41.8%)	12 (21.1%)	7 (87.5%)	14 (100.0%)
SAPT (single antiplatelet therapy)	23 (29.1%)	23 (40.4%)	0 (0.0%)	0 (0.0%)
No antithrombotic therapy	20 (25.3%)	20 (35.1%)	0 (0.0%)	0 (0.0%)
DOAC alone / combination	3 (3.8%)	2 (3.5%)	1 (12.5%)*	0 (0.0%)

TABLE 1: Baseline characteristics, aneurysm location, initial occlusion status, and discharge medication according to treatment modalities

PcomA: posterior communicating artery; AchoA: anterior choroidal artery; DAPT: dual antiplatelet therapy; DOAC: direct oral anticoagulant; SAPT: single antiplatelet therapy

Unscheduled visits and the first outpatient follow-up

Seven cases (8.9% of the cohort) required unscheduled outpatient visits prior to their first scheduled appointment. In the non-stent coiling group (n = 3), the reasons for unscheduled visits included an access site complication, cerebral ischemic symptoms, and headache and dizziness (each in one case). In the stent-assisted coiling group (n = 1), the reason for the unscheduled visit was headache. Conversely, the FD group accounted for three patients who presented with intracranial hemorrhage, worsening of visual symptoms, and headache (each in one case). The patients who experienced intracranial hemorrhage and visual worsening required immediate inpatient readmission due to the severity of these adverse events.

Excluding these seven unscheduled patients, a total of 72 cases attended their first regular scheduled outpatient visit. For these cases, the interval from treatment to the visit averaged 34.6 ± 17.5 days (median: 33.0 days, IQR: 18.0 days, range: 10-110 days). Clinical management at the first visit included consultation only (no APT prescription) in 30 cases and APT or antithrombotic prescription in 42 cases (continuation or adjustment in 26, dose reduction in 16). Five patients exhibited symptoms related to bleeding tendencies, such as subcutaneous hematoma, at the first visit, and APT dose reduction was conducted in three of these cases. Regarding radiological evaluation, nine cases (12.5% of the scheduled group) underwent their initial follow-up MRI concurrently on the day of their first outpatient visit, whereas the remaining cases scheduled their imaging at a later date. One patient in the FD group presented with neurological deterioration secondary to mass effect exacerbation at the first scheduled visit, which necessitated an emergency inpatient admission. The timing of scheduled outpatient visits and radiological follow-up is summarized in Table *2*.

Follow-up event	Number of cases (n)	Mean ± SD (days)	Median (days)	IQR (days)	Range (min–max) (days)
Clinical follow-up					
First scheduled outpatient visit	72	34.6 +/- 17.5	33.0	18.0	10–110
Radiological follow-up					
Initial scheduled MRI (early phase)	66	90.2 +/- 33.0	96.0	35.8	22–179
Second scheduled MRI (delayed phase)	57	317.1 +/- 110.0	305.0	109.0	103–586
Final MRI follow-up (long-term phase)	59	417.3 +/- 126.8	383.0	135.0	205-799

TABLE 2: Summary of elapsed time (days) from procedure to outpatient visits and follow-up MRI

Among the 59 cases with long-term MRI follow-up, two cases were excluded from the second scheduled MRI analysis due to uncertain examination timing (n = 57).

Symptomatic adverse events during subsequent outpatient follow-up

During subsequent outpatient follow-up after the first visits, symptomatic adverse events occurred in three patients. These consisted of drug-induced pancytopenia attributed to clopidogrel at 4.5 months post-FD placement (one patient), a scattered cerebral infarction due to self-discontinuation of APT at 14.5 months post-stent-assisted coiling (one patient), and a symptomatic white matter lesion caused by a suspected foreign-body granuloma at three months post-balloon-assisted coiling (one patient).

Adverse events within three months post-procedure according to medication status at discharge

We examined early adverse events occurring within three months post-procedure according to antithrombotic status at discharge. For this analysis, three cases receiving oral anticoagulants were included in the APT group as part of post-procedural antithrombotic management.

In the non-APT group (n = 20 cases), no hemorrhagic adverse events were observed (0%), although two patients (10.0%) developed ischemic symptoms. Conversely, in the APT group (n = 59 cases), no ischemic adverse events were documented (0%), whereas eight patients (13.6%) experienced hemorrhagic adverse events.

The remaining 51 cases (86.4%, 51/59) in the APT group and 18 (90.0%, 18/20) in the non-APT group had no adverse events. Descriptively, early hemorrhagic events occurred exclusively in the APT group, while early ischemic symptoms occurred only in the non-APT group. Early post-procedural adverse events according to discharge antithrombotic status are summarized in Table *3*.

Post-procedural adverse events	APT group (n = 59)	Non-APT group (n = 20)	Total (n = 79)
Ischemic events			
Ischemic stroke / transient ischemic attack	0 (0.0%)	2 (10.0%)	2 (2.5%)
Hemorrhagic events			
Intracranial hemorrhage	1 (1.7%)	0 (0.0%)	1 (1.3%)
Puncture site complications	2 (3.4%)	0 (0.0%)	2 (2.5%)
Minor bleeding (subcutaneous bleeding, epistaxis, etc.)	5 (8.5%)	0 (0.0%)	5 (6.3%)
Total patients with hemorrhagic events	8 (13.6%)	0 (0.0%)	8 (10.1%)

TABLE 3: Summary of post-procedural adverse events categorized by medication status at discharge

APT: antiplatelet therapy

Radiological follow-up (MRI) outcomes

Excluding MRIs obtained during unscheduled visits, the initial scheduled MRI (early phase) was performed in 66 cases at a mean of 90.2 ± 33.0 days (median: 96.0 days, IQR: 35.8 days, range: 22-179 days) after treatment. At this time point, no radiological evidence of aneurysm recurrence or marked deterioration of embolization status was observed, and no new ischemic lesions were detected. However, white matter lesions suggestive of foreign-body granulomas were identified in two patients (including one symptomatic patient requiring hospitalization) [4], and moderate parent artery stenosis was observed in one patient.

After excluding cases with uncertain examination timing, the second scheduled MRI (delayed phase) was performed in 57 cases at a mean of 317.1 ± 110.0 days (median: 305.0 days, IQR: 109.0 days, range: 103-586 days) after treatment. At this time point, two of the 57 cases (3.5%) demonstrated intra-aneurysmal blood flow signals suggestive of aneurysm recurrence.

A total of 59 cases completed long-term MRI follow-up, including two cases in which the precise timing of the second scheduled MRI could not be identified (n = 57 for the second scheduled MRI analysis). The overall mean final MRI follow-up period across the evaluated cohort was 417.3 ± 126.8 days (median: 383.0 days, IQR: 135.0 days, range: 205-799 days; corresponding to approximately 6.7 to 26.3 months). During the entire follow-up period, no aneurysm rupture occurred. Overall, aneurysm recurrence was identified in 5.1% (three of the 59 cases) with the long-term imaging follow-up cohort (corresponding to 3.8% (3/79) of the total cohort), observed at 14, 15, and 24 months post-procedure. Among these cases, one patient (1.7% (1/59) of cases with long-term MRI follow-up; corresponding to 1.3% (1/79) of the total cohort) underwent endovascular retreatment. The timing of radiological follow-up is summarized in Table *2*.

Discussion

The present study demonstrated that the clinical course after endovascular treatment for unruptured intracranial aneurysms differs according to treatment modality and post-procedural antithrombotic management. Early symptomatic complications were observed almost exclusively in patients requiring intensive antiplatelet therapy, particularly those treated with FDs. Intracranial hemorrhage, worsening visual symptoms, and progressive mass effect resulted in unscheduled outpatient visits or emergency readmission, highlighting the importance of close clinical surveillance during the first month after treatment. These findings are consistent with previous reports describing the unique risk profile associated with flow-diverting devices [5].

By contrast, early radiological follow-up yielded limited additional information regarding aneurysm recurrence. No recurrence was detected on initial follow-up MRI performed at a mean of 90.2 days (range: 22-179 days) after treatment, although clinically relevant incidental findings, including suspected foreign-body granulomas and parent artery stenosis, were identified. While valuable for identifying uncommon treatment-related complications, these observations suggest that routine MRI within the first month is unlikely to improve detection of aneurysm recurrence in appropriately selected patients.

Several investigators have demonstrated that aneurysm recurrence after coil embolization generally develops over a longer time course rather than in the immediate post-procedural period [1,3,6-11]. Long-term follow-up remains essential because delayed recanalization and recurrence may occur several years

after treatment. Specifically, Crobeddu et al. reviewed two decades of literature on post-coiling recurrence across both ruptured and unruptured aneurysms, emphasizing that managing recurrent aneurysms requires evaluating long-term occlusion stability rather than relying on immediate retreatment [8]. Rizvi et al. reported an overall retreatment rate of 4.9% and an annual post-treatment rupture rate of only 0.48%, identifying aneurysm size and incomplete initial occlusion as the principal predictors of recurrence [11]. Likewise, Abdalkader et al. found that major recurrence within the first six months was uncommon and was not observed among satisfactorily treated unruptured aneurysms [6]. Furthermore, a recent review on unruptured aneurysms by Cho et al. demonstrated that routine early follow-up MRA rarely alters clinical management in adequately occluded, low-risk cases, reinforcing the feasibility of deferring initial imaging in stable patients [7].

Regarding FD placement, long-term occlusion stability remains the primary focus. Landmark studies, such as the PUFS trial, have demonstrated that complete aneurysm occlusion rates progressively increase over time, exceeding 95% at five years with minimal delayed recanalization [12]. In addition, a comprehensive meta-analysis by Shehata et al. demonstrated that long-term occlusion rates following FD treatment for unruptured aneurysms progressively increased over time, from 77.0% at one year to 89.4% at three years and 96.0% at five years, with no delayed ruptures and a low overall in-stent stenosis rate of 4.8% [13]. Furthermore, in-stent stenosis typically stabilizes or spontaneously regresses within one year post-procedure without clinical sequelae [14]. Therefore, early asymptomatic vessel changes may not necessarily warrant immediate re-intervention, providing an initial rationale for a streamlined, risk-stratified follow-up strategy. In our study, aneurysm recurrence was identified in three of the 59 cases with long-term radiological follow-up (5.1%; corresponding to 3.8% [3/79] of the overall cohort) at 14, 15, and 24 months post-procedure, spanning a mean final MRI follow-up period of 417.3 days (range: 205-799 days).

Descriptively, coil-based treatments (comprising 57 non-stent and eight stent-assisted procedures) and FD placement exhibited distinct clinical profiles without formal statistical hypothesis testing. Taken together with our findings, these studies suggest that routine MRI within the first month provides limited additional value for detecting aneurysm recurrence, whereas continued long-term radiological surveillance remains essential. Based on these findings, outpatient follow-up should be individualized according to treatment modality and patient risk. Patients undergoing FD placement or stent-assisted coil embolization, particularly those requiring prolonged antiplatelet therapy, warrant early clinical assessment because of the risk of procedure- and medication-related complications. Conversely, patients achieving satisfactory non-stent coil embolization without post-discharge antiplatelet therapy experienced an uncomplicated early clinical course and no early recurrence in our cohort. For these carefully selected low-risk patients, deferring the first routine outpatient visit and MRI until approximately three months after treatment may represent a feasible option, provided that long-term radiological surveillance is maintained. Early follow-up should nevertheless remain available whenever clinically indicated or requested by the patient. To our knowledge, few previous studies have specifically addressed the optimal timing of routine outpatient follow-up after endovascular treatment for unruptured intracranial aneurysms. Our findings integrate both clinical and radiological outcomes to provide a preliminary, risk-stratified framework.

This study has several limitations. First, its retrospective design and relatively small sample size limit the generalizability of the findings and inherently introduce potential selection bias. Second, as no formal statistical testing was performed, subgroup comparisons remain purely descriptive. Third, treatment strategies and follow-up schedules were not completely standardized, which may have led to confounding by treatment indication (e.g., selection of FDs or stent-assisted coiling based on complex aneurysm morphology or location). Fourth, the relatively short follow-up period and the lack of long-term MRI follow-up data for a portion of cases (59 of 79 cases completed long-term MRI follow-up) may introduce potential follow-up bias in evaluating long-term aneurysm recurrence. Finally, platelet function testing was not routinely performed, precluding assessment of the relationship between antiplatelet responsiveness and adverse events. Consequently, the risk-stratified outpatient follow-up strategy proposed in this study should be interpreted as a preliminary proposal rather than a definitive protocol, and larger prospective, longitudinal studies are warranted to validate its feasibility.

Conclusions

Post-procedural stratified outpatient follow-up after endovascular treatment for unruptured intracranial aneurysms may be optionally tailored according to treatment modality and post-discharge antiplatelet management. Patients treated with flow diverters or stent-assisted coil embolization require close early clinical surveillance because of the risk of procedure- and medication-related complications. By contrast, our preliminary observations suggest that carefully selected patients who achieve satisfactory coil embolization without stent deployment or post-discharge antiplatelet therapy could safely defer the first routine outpatient visit and MRI until approximately three months after treatment, provided that appropriate long-term radiological surveillance is maintained. This risk-stratified follow-up strategy may facilitate more efficient postoperative management while maintaining patient safety and preserving the option of individualized early follow-up when clinically indicated or requested by the patient. Given our retrospective design and modest sample size, this pilot framework provides an initial step toward streamlining post-procedural care while preserving patient safety.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Noriaki Matsubara

Acquisition, analysis, or interpretation of data: Noriaki Matsubara, Kosumo Noda, Hiroaki Nomura, Masanori Gomi, Soichiro Yasuda, Shota Yoshitomi, Shiro Nagasawa, Eimei Tsuda

Drafting of the manuscript: Noriaki Matsubara

Critical review of the manuscript for important intellectual content: Kosumo Noda, Hiroaki Nomura, Masanori Gomi, Soichiro Yasuda, Shota Yoshitomi, Shiro Nagasawa, Eimei Tsuda

Supervision: Shiro Nagasawa, Eimei Tsuda

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Review Board (IRB) of Soseikai General Hospital issued approval RIN R8-24. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

The authors would like to express their sincere gratitude to all the clinical staff at Soseikai General Hospital, Tosei General Hospital, and Osaka Medical College Hospital for their invaluable support in compiling the patient dataset and managing patients throughout this study.

References

1. Wallace RC, Karis JP, Partovi S, Fiorella D: Noninvasive imaging of treated cerebral aneurysms, part I: MR angiographic follow-up of coiled aneurysms. AJNR Am J Neuroradiol. 2007, 28:1001-8. 10.3174/ajnr.A0662
2. Thompson BG, Brown RD Jr, Amin-Hanjani S, et al.: Guidelines for the management of patients with unruptured intracranial aneurysms: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2015, 46:2368-400. 10.1161/STR.0000000000000070
3. Soize S, Gawlitza M, Raoult H, Pierot L: Imaging follow-up of intracranial aneurysms treated by endovascular means: why, when, and how?. Stroke. 2016, 47:1407-12. 10.1161/STROKEAHA.115.011414
4. Kitamura T, Oishi H, Fujii T, Teranishi K, Yatomi K, Yamamoto M, Arai H: Delayed complications due to polymer coating embolism after endovascular treatment. NMC Case Rep J. 2020, 7:5-10. 10.2176/nmccrj.cr.2018-0319
5. Miyachi S, Kawaguchi R: Adjunctive coiling in flow diverter treatment does not prevent delayed rupture: a nationwide survey. Neurointervention. 2025, 20:66-70. 10.5469/neuroint.2025.00129
6. Abdalkader M, Raymond J, Mian A, et al.: Early major recurrence of cerebral aneurysms after satisfactory initial coiling. Interv Neuroradiol. 2021, 27:172-80. 10.1177/1591019920968370
7. Cho YH, Choi J, Huh CW, et al.: Imaging follow-up strategy after endovascular treatment of intracranial aneurysms: a literature review and guideline recommendations. J Cerebrovasc Endovasc Neurosurg. 2024, 26:1-10. 10.7461/jcen.2024.E2023.08.008
8. Crobeddu E, Lanzino G, Kallmes DF, Cloft HJ: Review of 2 decades of aneurysm-recurrence literature, part 2: managing recurrence after endovascular coiling. AJNR Am J Neuroradiol. 2013, 34:481-5. 10.3174/ajnr.A2958
9. Goto S, Izumi T, Nishihori M, et al.: Antiplatelet therapy discontinuation after stent-assisted coil embolization for intracranial aneurysms: a single-center, long-term, retrospective, observational study. J Neurosurg. 2023, 138:724-31. 10.3171/2022.6.JNS22815
10. Koyanagi M, Ishii A, Imamura H, et al.: Long-term outcomes of coil embolization of unruptured intracranial aneurysms. J Neurosurg. 2018, 129:1492-8. 10.3171/2017.6.JNS17174
11. Rizvi A, Seyedsaadat SM, Alzuabi M, Murad MH, Kadirvel R, Brinjikji W, Kallmes DF: Long-term rupture risk in patients with unruptured intracranial aneurysms treated with endovascular therapy: a systematic review and meta-analysis. AJNR Am J Neuroradiol. 2020, 41:1043-8. 10.3174/ajnr.A6568
12. Becske T, Brinjikji W, Potts MB, et al.: Long-term clinical and angiographic outcomes following Pipeline Embolization Device treatment of complex internal carotid artery aneurysms: five-year results of the Pipeline for uncoilable or failed aneurysms trial. Neurosurgery. 2017, 80:40-8. 10.1093/neuros/nyw014
13. Shehata MA, Ibrahim MK, Ghozy S, Bilgin C, Jabal MS, Kadirvel R, Kallmes DF: Long-term outcomes of flow diversion for unruptured intracranial aneurysms: a systematic review and meta-analysis. J Neurointerv Surg.

2023, 15:898-902. 10.1136/jnis-2022-019240

14. Gui S, Chen X, Wei D, et al.: Long-term outcomes and dynamic changes of in-stent stenosis after Pipeline embolization device treatment of intracranial aneurysms. J Neurointerv Surg. 2023, 15:1187-93. 10.1136/jnis-2022-019680