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POST-PROCEDURAL OUTCOMES IN SUBARACHNOID HEMORRHAGE PATIENTS FOLLOWING ENDOVASCULAR COILING FOR ANEURYSM RUPTURE AT DR. MOEWARDI GENERAL HOSPITAL, SURAKARTA, INDONESIA

Shafira Nur Hanifa[1*], Subandi[2]

***Correspondence**: shafiranurhanifa@gmail.com*
[1]Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia
[2]Deparment of Neurology, Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia

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ABSTRACT

Background: The insidious event of a ruptured intracranial aneurysm (IA) poses the requirement for urgent and effective medical intervention. Endovascular coiling came as an efficacious treatment option. However, no conclusive guideline is available regarding the best time to perform endovascular coiling on the ruptured IA.
Objective: The study aims to evaluate the association of timing with endovascular coiling treatment and the post-procedural outcome.
Methods: A retrospective cohort study was conducted on a Subarachnoid Hemorrhage (SAH) patient who underwent endovascular coiling on Dr. Moewardi General Hospital, Surakarta, Indonesia, between January 2021 and December 2023. The association between time to endovascular coiling and the postoperative outcome (evaluated by hospitalization duration, modified Rankin Score/mRS, and mortality) was assessed.
Results: Of the 50 patients included in the study, it was observed that the aneurysms treated varied in size from 3.1 to 13 mm, with the internal carotid artery being the most common location. The analysis revealed that early intervention, performed within the first 3 days after rupture, significantly reduced the length of hospital stay compared to delayed intervention (6.467 vs. 8.80 days, $p < 0.030$) and resulted in better functional outcome, evaluated by mRS ($p < 0.003$). Despite the positive outcomes, the study also reported a postoperative mortality incidence in three patients.
Conclusion: Earlier endovascular coiling in SAH patients can lead to shorter hospitalization and improved functional outcomes, highlighting the importance of timely intervention in managing this critical condition.

Keywords: coil embolization, coiling, endovascular aneurysm repair, intracranial aneurysm, subarachnoid hemorrhage

Introduction

Ruptured intracranial aneurysms (IA) lead to subarachnoid hemorrhage (SAH)[1,2] Yielding 9.1 per 100,000 person-years in most parts of the world.[3] Aneurysmal SAH poses a high mortality rate, up to 50% of cases, and surviving patients develop permanent neurological and cognitive impairments; 4 only 6-17% of survivors can return to work.[5] Thus, IA, particularly when ruptured, represents a critical condition requiring urgent and effective medical intervention.[6,7] Endovascular coiling has revolutionized the management of ruptured intracranial aneurysms, offering a minimally invasive alternative to surgical clipping.[8] Despite its advantageous effect on better recovery times, lower morbidity, and mortality levels than surgical clipping,[8,9] the optimal timing for performing endovascular coiling post-rupture remains a topic of debate within the medical community.

Timely intervention is believed to be crucial for improving clinical outcomes in patients with ruptured intracranial aneurysms. Delays in treatment can exacerbate neurological damage and increase the risk of re-bleeding, cerebral vasospasm, and cerebral infarction, which lead to poorer functional outcomes and more extended hospital stays.[5,10,11] Conversely, premature intervention without adequate patient stabilization might also pose risks.[2,12] Previous studies regarding the ideal onset for endovascular coiling in ruptured IA patients are still inconclusive, although several studies suggest early treatment (the first 1-3 days).[13-15] Balancing these factors is crucial for optimal patient care and resource use.

This study aims to investigate the impact of the timing of endovascular coiling on post-procedural outcomes in patients who have suffered a ruptured intracranial aneurysm. Specifically, we will explore how the interval between aneurysm rupture and the endovascular coiling center influences the post-procedural outcome, assessed by hospitalization duration, modified Rankin Score/mRS, and mortality. By elucidating these relationships, we hope to provide valuable insights that can inform clinical guidelines and improve the prognosis for patients experiencing this life-threatening condition.

Methods

Ethics and study design

This study is a retrospective cohort analysis conducted at Dr. Moewardi General Hospital, Surakarta, Indonesia, a tertiary care center specializing in neurovascular interventions. The study period spans from January 2021 to December 2023. The Research Ethics Committee of Dr. Moewardi General Hospital, Surakarta, Indonesia, approved this study. Patient confidentiality was maintained by anonymizing data during the analysis.

Patient selection

We included patients diagnosed with ruptured intracranial aneurysms who underwent endovascular coiling within the study period. Inclusion criteria were: Age 18 years or older, confirmed diagnosis of ruptured intracranial aneurysm using imaging modalities (non-contrast head CT scan and digital subtraction angiography). The exclusion criteria were patients with atypical IA, those surgically treated other than using endovascular coiling, and incomplete medical records.

Data collection

Data were extracted from electronic medical records, including demographic information, clinical presentation details, radiological findings (aneurysm location and size), timing from aneurysm symptoms to treatment (presented in days), length of hospital stay (in days), Functional outcomes assessed using length of hospital stay, mRS and mortality rate. A modified Raymond Roy Classification/ MMRC score was also reported. MMRC is classified as class I: complete obliteration; class II: residual neck; class IIIa: residual aneurysm with contrast within coil interstices; class IIIb: residual aneurysm with contrast along aneurysm wall.[16] SAH symptoms are defined as the first onset of a patient complaining of severe headaches (thunderclap headache); the patient was observed having loss of consciousness, seizure, or the development of other neurological impairments.[5] Time to endovascular coiling was classified into two categorical groups: early group (treated within 3 days after onset) and delay group (treated within 4-14 days after onset).[12]

Outcome measure

The primary outcome measures were the length of hospital stay, functional outcome measured using mRS, and mortality rate. The secondary outcomes of the study were the MRRC score and re-bleeding incidence.

Statistical analysis

Data analysis was performed using SPSS version. 18.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were employed to describe the demographics and characteristics of the entire sample. Continuous variables were expressed as mean ± standard deviation for normally distributed data and as median (min-max) for data with an abnormal distribution. Categorical variables were presented as frequencies and percentages. Comparative analysis between the timing groups was conducted using the Independent T-test or the Mann-Whitney U test. Statistically significant was defined as a p-value <0.05.

Results

During the study, 62 patients underwent endovascular coiling. However, 12 of them did not fulfill the criteria for the study. So, the study included 50 patients who underwent endovascular coiling to treat ruptured intracranial aneurysms. Most subjects studied were female, accounting for 37 (74%) patients, compared to the men (13). The aneurysm size ranges from 3.1 to 13 mm with a mean of 6.16 mm, and the most prevalent location to occur is the internal carotid artery (ICA) (36%), followed by the anterior communicating artery (AComm) (24%), middle cerebral artery (MCA) (16%) and anterior cerebral artery (ACA) (16%), posterior communicating artery (PComm) (6%), then posterior cerebral artery (PCA) (2%). According to MRRC results, no patient developed MRRC grade IIIB; only grades I and II were observed in the early intervention group (Table 1).

Table 1. Demographic characteristics of the study subjects

Category	Mean (SD)	Median (Min-Max)	N (%)
Age (Years)		57.5 (19-79)	
Aneurysm Size (mm)		5.895 (3.1-13)	
Gender			
Male			13 (26)
Female			37 (74)
Location of Aneurysm			
ICA			18 (36)
MCA			8 (16)
ACA			8 (16)
PCA			1 (2)
PComm			3 (6)
AComm			12 (24)
Length of Stay		7 (4-15)	
Time to Coiling	5.7 (3.1)		
Functional Outcome mRS			
0-2			35 (70)
3-6			15 (30)
Re-bleeding			3 (6)
Mortality			3 (6)
MRRC			
Grade I			32 (64)
Grade II			14 (28)
Grade IIIA			4 (8)
Grade IIIB			-

ICA: Internal Carotid Artery, MCA: Middle Cerebral Artery ACA: Anterior Cerebral Artery, PCA: Posterior Cerebral Artery

The Mann-Whitney U test was used to compare the duration of hospital stays between two groups: one receiving early intervention and the other receiving delayed intervention. This test was chosen because it is suitable for comparing distributions when the data does not follow a normal distribution, focusing on differences in the ranks of hospital stay lengths. The analysis revealed a statistically significant difference in hospital stay duration between the early intervention group (M = 6.467 days, SD = 1.807) and the delayed intervention group (M = 8.80 days, SD = 3.445), t = -2.471, $p < 0.05$ (Figure 1).

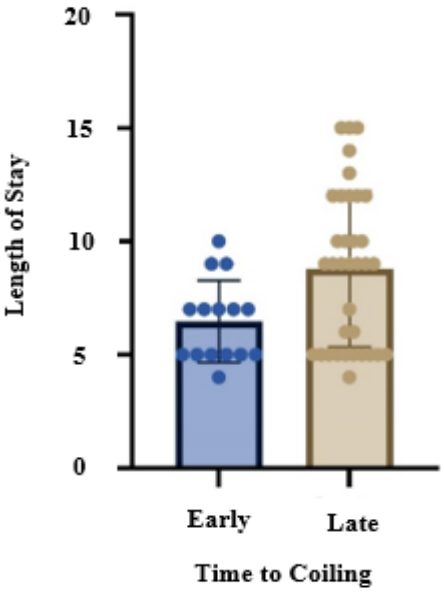

Figure 1. The difference between time to coiling and the length of stay revealed a statistically significant difference in hospital stay duration between the early intervention group (M: 6.467 days, SD: 1.807) and the delayed intervention group (M: 8.80 days, SD: 3.445), t: -2.471, $p < 0.05$

A Mann-Whitney U test was conducted to compare the distributions of functional outcome scores (measured by the mRS) between the early and delayed intervention groups. The results indicated a statistically significant difference in functional outcome scores between the early and delayed intervention groups, $p < 0.05$ (Figure 2).

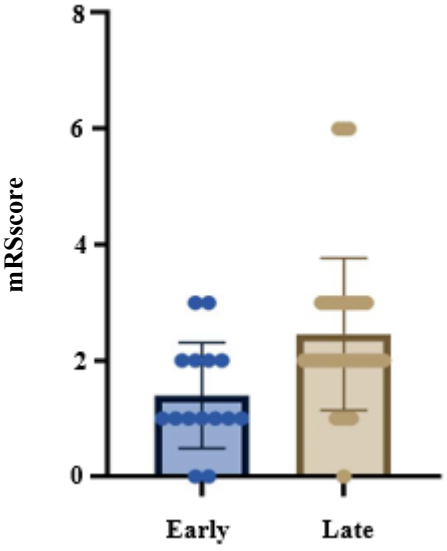

Figure 2. Difference between time to coiling and mRS observed a statistically significant difference in functional outcome scores (evaluated using mRS) between the early intervention group (1.4±0.91) and the delayed intervention group (2.46±1.31), $p < 0.05$. The mean mRS in this study was 2.14±1.294

Discussion

This study evaluated the impact of the timing of endovascular coiling on the outcomes of patients with ruptured intracranial aneurysms. A total of 50 patients out of 62 initially observed met the inclusion criteria and were included in the study. The predominance of female patients (74%) aligns with existing epidemiological data suggesting that women were more likely to rupture intracranial aneurysms than men, with a sex ratio of 1.5:1.[19] The aneurysms had a mean size of 6.16±2.26 mm and were most commonly located in the ICA, followed by the AComm, MCA and ACA, and PComm. Previous research found that most aneurysms rupture before reaching 7 mm in size, with the most frequent rupture sites being the AComm, followed by the internal carotid artery bifurcation (ICB) and the PComm.[20] A prior study indicated IA located in ICA with a size of <7mm, considered a low risk.[21] However, in this study, the patients were treated as ruptured IA, as per the possibility of the aneurysm shrinking after rupture,[20] making the measurement inaccurate.

Compared to other procedural methods for treating intracranial aneurysms, endovascular coiling is associated with a significantly shorter hospital stay ($p<0.001$).[22] This study further highlights that early intervention, performed within 1–3 days of symptom onset, significantly reduces hospital stay duration compared to delayed intervention initiated after 3 days. A better functional outcome, as measured by the mRS score, was observed in the early intervention group compared to the delayed intervention group (1.4 ± 0.91 vs. 2.46 ± 1.31, $p<0.05$). This finding suggests that early intervention reduces hospital stay and significantly enhances functional recovery. Nevertheless, favorable functional outcomes were achieved in both groups. A study found that early endovascular treatment within 24 hours of rupture improved functional recovery and reduced hospital stay. Of 457 patients, 71% recovered well (mRS 0-2), 11.2% had a negative outcome (mRS 3-5), and 17.8% died.[2] Previous research also stated that the beneficial effect of endovascular coiling for treating IA shows a lower dependency rate (as evaluated by the mRS score of 3-6) compared to surgical treatment, which is 23.7% and 30.6%, respectively.[23]

Despite the overall positive outcomes, the study reported a postoperative mortality rate of 6%, with three cases observed in the delayed intervention group. Two patients developed acute respiratory distress syndrome, and the rest had poor clinical conditions on admission. Although re-rupture was considered as one of the causes of poor outcomes,[12] only one patient with a re-rupture history died. This number is lower than the previous research on the mortality rate after long-term follow-up, which was reported in 7.1% of patients who underwent the endovascular coiling procedure; even more, the mortality rate is lower than that of the surgical intervention group, which was 9.8%.[24] During the first 48 hours following endovascular coil treatment of aneurysms, there is the most significant risk of hemorrhagic consequences.[25] In this study, although re-rupture was reported in three cases (6%), the incidence occurred a year after the coiling in two cases and two years after the coiling in one case. In this study, the re-bleeding rate was reported to be lower than in the previous study, in which previous literature reported up to 27%.[11,26,27]

In addition to optimal timing, achieving favorable outcomes in endovascular coiling requires careful consideration of other factors, including patient characteristics such as gender and age, and aneurysm-specific factors such as size and location. Attention to these variables is essential for enhancing procedural success and patient recovery. While the study provides valuable insights into the impact of timing on endovascular coiling outcomes for patients with ruptured intracranial aneurysms, several limitations must be acknowledged: limited sample size, retrospective design, single-center study, short follow-up period, and limited functional outcome measurement tools used. Addressing these limitations through larger, prospective, multi-center studies with standardized protocols and comprehensive outcome measures will be critical in validating and expanding upon the current findings.

Conclusion

The study observed that performing endovascular coiling earlier (1-3 days after onset) in patients with SAH after aneurysm rupture was significantly associated with shorter hospital stays and better functional outcomes. This study prioritizes early endovascular coiling in clinical protocols for ruptured intracranial aneurysms. Future research should focus on refining patient selection criteria, managing risk factors associated with rupture, and enhancing postoperative care to improve outcomes. Additionally, the broader application of these findings could contribute to developing standardized guidelines, ultimately improving survival rates and functional recovery for patients worldwide.

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