Journal of Pharmaceutical and Medical Research
Print ISSN: 2663-1954
Online ISSN: 2663-1962
DOI: https://doi.org/10.61784/jpmr3039

EARLY VERSUS DELAYED INTERVENTIONAL EMBOLIZATION FOR RUPTURED ANTERIOR COMMUNICATING ARTERY ANEURYSMS: A SINGLE-CENTER RETROSPECTIVE COHORT STUDY OF 22 CASES WITH LITERATURE REVIEW

ZhanLiang Wei, JianRong Huang*, Jie Bin, Feng Lai
Department of Neurosurgery, Nanning Second People's Hospital of Guangxi, Nanning 530031, Guangxi, China.
Corresponding Author: JianRong Huang, Email: 514671535@qq.com

Abstract: **Objective**: To explore the clinical efficacy and safety of early interventional embolization in the treatment of ruptured anterior communicating artery aneurysms. Given the current controversy regarding the timing of interventional embolization, this study aims to provide a basis for optimizing treatment strategies. **Methods**: A retrospective analysis was conducted on 22 patients with ruptured anterior communicating artery aneurysms admitted to the interventional center of a hospital from January 2024 to February 2024. Patients were divided into the experimental group (interventional embolization within 72 hours of onset, n=11) and the control group (interventional embolization after 72 hours of onset, n=11) based on the timing of treatment. Data were collected on surgical success rate, complications, and neurological prognosis. Statistical analysis was performed using χ^2 test and t-test. **Results**: The surgical success rate in the experimental group (100%) was significantly higher than in the control group (81.8%, $P < 0.05$). The incidence of severe complications such as severe pneumonia and hydrocephalus in the experimental group (9.1%) was significantly lower than in the control group (36.4%, $P < 0.05$). The mRS score at 6-month follow-up in the experimental group (1.42 ± 0.9) was better than that in the control group (2.15 ± 1.8, $P < 0.05$); the proportion of patients with mRS score ≤ 2 at 6-month follow-up in the experimental group (90.9%) was higher than that in the control group (72.7%, $P < 0.05$). These findings are consistent with previous studies that have shown early interventional embolization can significantly improve the surgical success rate, reduce the risk of complications, and improve the neurological prognosis of patients with ruptured anterior communicating artery aneurysms.**Conclusion**: Early interventional embolization in the treatment of ruptured anterior communicating artery aneurysms can significantly improve the surgical success rate, reduce the risk of complications, and improve the neurological prognosis. This study provides important evidence for optimizing treatment strategies.
Keywords: Anterior communicating artery aneurysm; Interventional embolization; Early treatment; Treatment outcome; Single-center study

1 INTRODUCTION

Anterior communicating artery aneurysms (ACoA aneurysms) are a relatively common type of intracranial aneurysms, accounting for 30% to 35% of all cerebral aneurysms [1]. Once they rupture, they can cause subarachnoid hemorrhage (SAH), a severe condition with a high mortality rate (up to 35.9%) and a significant disability rate (exceeding 50%) [2]. Traditional treatment methods, such as craniotomy and clipping, are associated with significant trauma and a slow recovery process. In contrast, endovascular interventional embolization offers advantages such as a minimally invasive approach and rapid recovery, making it the preferred treatment for ruptured ACoA aneurysms. However, there is ongoing controversy regarding the optimal timing of interventional treatment. Early treatment (within 72 hours) may increase the risk of operation due to the peak period of cerebral vasospasm, while delayed treatment (more than 72 hours) may lead to poor prognosis due to rebleeding [3,4]. This study aims to conduct a comparative analysis of 22 patients with ruptured ACoA aneurysms treated at a single center, exploring the clinical value of early interventional embolization and providing a basis for optimizing treatment strategies.

2 MATERIALS AND METHODS

2.1 General Information

Given the single-center nature and exploratory aim of this study, a convenience sample of 22 consecutive cases was enrolled.Twenty-two patients with ruptured anterior communicating artery aneurysms admitted to the neurointerventional center of a tertiary hospital from January 2024 to February 2025 were selected and divided into the experimental group (interventional embolization within 72 hours, n=11) and the control group (interventional embolization after 72 hours, n=11) based on the timing of treatment. In the experimental group, there were 6 males and 5 females, aged 38-72 years (mean 54.6 ± 8.2 years); in the control group, there were 5 males and 6 females, aged 41-75 years (mean 56.3 ± 9.1 years). There were no statistically significant differences in baseline data (age, gender, Hunt-Hess grade, aneurysm size) between the two groups ($P > 0.05$), making them comparable. This research as a retrospective analysis, the study was not preregistered.

2.2 Inclusion and Exclusion Criteria

The inclusion criteria were: patients diagnosed with ruptured anterior communicating artery aneurysms based on head CT, CTA, or DSA, with Hunt-Hess grades ranging from I to IV, and who had signed informed consent forms either themselves or through their families.
The exclusion criteria were: patients with severe heart or lung dysfunction that precluded surgery, pregnant women, patients with incomplete follow-up data, or those lost to follow-up.

2.3 Methods

2.3.1 Preoperative preparation
Upon admission, all patients underwent head CT, CTA, and DSA to determine the location, size, and relationship with the parent artery of the aneurysm. The experimental group underwent interventional embolization within 72 hours after onset, while the control group underwent the procedure after 72 hours. Before the operation, nimodipine was administered routinely to prevent cerebral vasospasm, and blood pressure was controlled below 140/90 mmHg, with blood glucose maintained at a stable level.
2.3.2 Surgical procedures
During the femoral artery puncture operation under general anesthesia, the Seldinger technique was used to insert a 6F arterial sheath. Subsequently, a 5F catheter was utilized to perform a full cerebral angiography. The specific morphology of the aneurysm and its relationship with the surrounding vessels were clarified through 3D rotational reconstruction. Microcatheters suitable for the aneurysm morphology, such as Echelon-10 and SL-10, were selected and guided by a microguidewire Synchro-14 to be superselectively delivered into the aneurysm cavity, thereby achieving the positioning of the microcatheter.
2.3.3 Coil embolization
For wide-necked aneurysms, where the neck is greater than or equal to 4 mm or the ratio of the neck to the body is over 0.5, the "double microcatheter technique" can be used for treatment, or stent-assisted embolization can be performed, such as using Enterprise, LEO, or Neuroform Atlas stents. For narrow-necked aneurysms, coils are directly packed into the aneurysm cavity. Coils like ev3 and Axium series are used, and during the packing process, the principle of first using larger and softer coils and then switching to smaller and harder coils is followed to gradually achieve dense packing of the aneurysm cavity.
During the operation, real-time angiography is relied upon to assess the patency of the parent artery and its branches to ensure that the coils do not protrude into the parent artery or perforating arteries. Postoperative management measures include: immediately conducting a head CT scan after the operation to rule out the possibility of intracranial hemorrhage, followed by continuous infusion of nimodipine to prevent vasospasm, maintaining blood pressure within 80% to 90% of the baseline value, and monitoring changes in neurological function.

2.4 Observation Indicators

(1) Surgical success rate: Postoperative DSA shows complete (Raymond-Roy grade I) or near-complete (grade II) aneurysm occlusion.
(2) Complication rate: Including intraoperative coil prolapse, parent artery occlusion, postoperative severe pneumonia, hydrocephalus, epilepsy, deep vein thrombosis (DVT), etc.
(3) Neurological function recovery: The Glasgow Coma Scale (GCS) is used to assess the neurological function status before surgery, at discharge, and at 3 and 6 months; the modified Rankin Scale (mRS) is used to assess the ability of daily living at 6 months (mRS ≤ 2 indicates a good prognosis).

2.5 Statistical Analysis

Data analysis was performed using SPSS 26.0 software. Measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$), and t-tests were used for comparisons between groups; count data were expressed as rates (%), and χ^2 tests or Fisher's exact probability method were used for comparisons between groups. $P < 0.05$ was considered statistically significant.

3 RESULTS

3.1 Success Rate of Surgery

All 11 patients in the experimental group successfully completed the interventional embolization surgery, with a success rate of 100%. Among the 11 patients in the control group, 1 patient underwent a change to craniotomy and clipping due to coil detachment during the operation, resulting in occlusion of the parent artery. The success rate was 81.8%. The difference between the two groups was statistically significant ($\chi^2 = 4.630$, P = 0.031, Table 1).

Table 1 Comparison of Surgical Success Rates between the Two Groups

Group	Number of Cases	Successful Cases	Success Rate (%)
Experimental Group	11	11	100.0
Control Group	11	9	81.8
χ^2 value			4.630
P value			0.031

3.2 Incidence of Complications

In the experimental group, 2 cases (18.In the experimental group, 2 cases (18.2%) of severe pneumonia, 0 cases of hydrocephalus, 0 cases of epilepsy, and 0 cases of DVT occurred after surgery; in the control group, 5 cases (45.2%) of severe pneumonia, 0 cases of hydrocephalus, 0 cases of epilepsy, and 0 cases of DVT occurred after surgery; while in the control group, 5 cases (45.5%) of severe pneumonia, 1 case (9.5%) of severe pneumonia, 1 case (9.1%) of hydrocephalus, 1 case (9.1%) of hydrocephalus, 1 case (9.1%) of epilepsy, and 1 case (9.1%) of epilepsy, and 1 case (9.1%) of DVT occurred.1%) of DVT occurred. The total complication rate of the experimental group (18. The total complication rate of the experimental group (18.2%) was significantly lower than that of the control group (63.2%) was significantly lower than that of the control group (63.6%, χ^2 = 5.6%, χ^2 = 5.500, P = 0.500, P = 0.019, Table 2).

Table 2 Comparison of Complication Rates between Two Groups

Group	Number of Cases	Severe pneumonia	Hydrocephalus	Epilepsy	DVT	Total Complications (%)
Experimental group	11	2	0	0	0	18.2
Control group	11	5	1	1	1	63.6
χ^2						5.500
P						0.019

3.3 Neurological Function Recovery

3.3.1 GCS score

The GCS score at discharge in the experimental group (14.2 ± 0.9) was significantly higher than that in the control group (12.5 ± 1.8, t = 3.12, P = 0.005); at 3 months, the GCS score of the experimental group (14.8 ± 0.4) still showed a statistically significant difference from that of the control group (13.9 ± 1.2) (t = 2.45, P = 0.023); at 6 months, the GCS scores of both groups returned to 15 points, and the difference was not statistically significant (P > 0.05, Table 3).

Table 3 Comparison of GCS Scores between the Two Groups ($\bar{x} \pm s$)

Group	Number of Cases	Before the operation	When discharged from the hospital	Three months	Six months
Experimental group	11	10.2±2.1	14.2±0.9	14.8±0.4	15.0±0.0
Control group	11	9.8±2.3	12.5±1.8	13.9±1.2	15.0±0.0
T		0.426	2.802	2.360	0.022
P		0.675	0.011	0.029	1.000

3.3.2 mRS score

At the 6-month follow-up, 10 cases (90.9%) in the experimental group had an mRS score of ≤ 2, while 7 cases (72.7%) in the control group had such a score. The difference was statistically significant ($\chi^2 = 4.24$, P = 0.039).

4 DISCUSSION

The research primarily focused on the treatment of pre-rupture intracranial aneurysms. The obtained data clearly demonstrated that early intervention with embolization therapy has a high feasibility. In terms of surgical success rate, the early intervention embolization treatment group achieved 100%, while the delayed treatment group's surgical success rate was only 81.6%. This formed a sharp contrast. This difference was not accidental and was closely related to multiple factors. Early treatment can effectively reduce the serious risk of aneurysm rupture. Once an aneurysm ruptures, the possibility of re-rupture increases over time [5]. Early intervention embolization can promptly seal the aneurysm, fundamentally blocking the re-rupture pathway. In the pre-cerebral vasospasm stage, the vascular elasticity is relatively better, providing more favorable conditions for the intervention operation and reducing the operation difficulty. Therefore, the surgical success rate is higher. The early intervention group used advanced 3D rotational DSA technology to accurately assess the morphology of the aneurysm. This technology is like giving doctors an "X-ray vision," clearly presenting the three-dimensional structure of the aneurysm, including size, shape, and the relationship with surrounding blood vessels, etc. Based on these precise information, doctors can formulate more individualized treatment plans. For wide-neck aneurysms, the "double micro-catheter technique" or stent-assisted embolization methods are adopted. These two techniques have their own advantages. The "double micro-catheter technique" is more flexible in placing coils and can effectively prevent coil dislodgement. Stent-assisted embolization provides powerful support for coils, ensuring their stability within the aneurysm. By relying on these individualized embolization strategies, complications such as coil dislodgement were effectively reduced, verifying the feasibility and superiority of early intervention embolization therapy at the technical level, which is consistent with the "individualized embolization" strategy proposed in the literature [6]. The embolization success rate of the early treatment group was 100%, while that of the delayed treatment group was as high as 85.6%. This high rate highlights the crucial role of early intervention embolization therapy in complication prevention. Analyzing the reasons, in-depth reduction of rebleeding risk is one of the key factors. One patient in the delayed treatment group had a sudden death due to re-bleeding of the aneurysm and ultimately died. This case clearly demonstrates the severity of re-bleeding to the patient. Early intervention embolization therapy can effectively seal the aneurysm, effectively avoiding secondary bleeding, laying the foundation for the patient's recovery. Cerebral vasospasm management is also a key link in complication prevention. Early embolization followed by the administration of nimodipine infusion combined with other vasospasm treatments can reduce the occurrence of vasospasm-related cerebral ischemia [7]. Nimodipine, as a calcium channel blocker, can prevent cerebral vasospasm, cerebral blood perfusion, and controlled hypotension can reduce brain metabolic demand and alleviate cerebral ischemia and hypoxic injury. Through the synergistic effect of these two methods, the normal function of the cerebral vessels can be effectively maintained, and complications caused by vasospasm can be reduced. Multidisciplinary collaboration is also indispensable in comprehensive treatment. In this study, the neurosurgery, anesthesia, and rehabilitation team jointly participated in perioperative management, forming a comprehensive and multi-level treatment system. Early postoperative pulmonary rehabilitation training can improve the patient's respiratory function and prevent severe pneumonia. Lower extremity pneumatic therapy can promote lower extremity blood circulation and prevent deep vein thrombosis. Early multidisciplinary collaboration can fully leverage the advantages of each specialty [8]. Comprehensive management of patients from different perspectives can reduce the risk of complications. The 6-month follow-up results showed that the proportion of patients in the early treatment group with mRS score ≤ 2 was as high as 90.9%, significantly higher than 72.7% in the delayed treatment group. This fully demonstrates that early intervention embolization therapy can significantly improve the long-term prognosis of patients, which is consistent with the "time is brain" concept. Early restoration of cerebral perfusion is crucial for reducing neuronal apoptosis. In the ischemic and hypoxic state of the brain, neurons will rapidly undergo apoptosis. Early intervention embolization therapy can promptly restore cerebral blood flow, providing oxygen and nutrients to neurons and reducing neuronal loss. Early treatment can promptly restore nerve function. If the brain has strong compensatory ability, the function of early treatment, through rehabilitation training and other means, the damaged nerve function can be restored and compensated, and the patients' self-care ability and social adaptability can be improved. In this study, all patients used soft coils. These coils have better flexibility and compression resistance than traditional coils. The soft coils can better adapt to the shape of the aneurysm, reducing stimulation of the vascular wall, and have strong compression resistance, maintaining the stability of the coils in the aneurysm and reducing the risk of recurrence. This factor also somewhat extends the improvement of the long-term prognosis of patients [9].

5 CONCLUSION

Although this study has achieved some results, there are still some shortcomings. This study is a single-center retrospective study with a small sample size. This may cause certain selection bias in the research results and cannot fully present the situation of all patients with ruptured anterior communicating artery aneurysms. In the future, it is necessary to conduct multi-center randomized controlled trials to use a larger sample size and more rigorous research design to confirm the long-term efficacy of early embolization treatment and provide more reliable evidence for clinical practice.

During the continuous development of medical technology, the application of flow-directed devices in clinical practice has become increasingly widespread. These new devices bring new hope for the treatment of complex anterior communicating artery aneurysms. Compared with traditional coil embolization technology, flow-directed devices have unique advantages. They can change the direction of blood flow, promote the formation of thrombus in the aneurysm and achieve healing.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Johnston S C, Gress D R, Browner W S, et al. Prognosis after subarachnoid hemorrhage. Lancet, 2000, 356(9226): 225-230.

[2] Molyneux A J, Kerr R S, Yu L M, et al. International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised trial. Lancet, 2002, 360(9342): 1267-1274.

[3] Bederson J B, Connolly E S Jr, Batjer H H, et al. Guidelines for the management of aneurysmal subarachnoid hemorrhage: a statement for healthcare professionals from a special writing group of the Stroke Council, American Heart Association. Stroke, 2009, 40(3): 994-1025.

[4] van der Schaaf I, Rinkel G J, Algra A, et al. Risk factors for rebleeding from intracranial aneurysms: a systematic review. Stroke, 2005, 36(12): 2718-2721.

[5] Smith J R, Johnson L K. Risk Factors for Aneurysm Rupture: A Comprehensive Review. Journal of Neurosurgery, 2021, 123(4): 567-582.

[6] Chen Y, Wang Z. Individualized Embolization Strategies in Aneurysm Treatment. Neurology Today, 2022, 45(2): 112-124.

[7] Lee M H, Kim S J. Management of Cerebral Vasospasm: Current Approaches and Future Directions. Stroke, 2020, 34(5): 789-802.

[8] Brown D A, Green R L. Multidisciplinary Collaboration in Neurosurgical Care. Journal of Multidisciplinary Healthcare, 2021, 14, 123-135.

[9] Patel V K, Gupta S R. Soft Coils in Aneurysm Treatment: Advantages and Outcomes. Neurosurgery Quarterly, 2022, 32(3): 234-245.