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ADVANCING CARE FOR DISTAL ANTERIOR CEREBRAL ARTERY ANEURYSMS : FIVE YEAR INSTITUTIONAL INSIGHTS INTO ENDOVASCULAR TREATMENT

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ABSTRACT **Background:** Distal anterior cerebral artery (DACA) aneurysms, located within the A2 to A5 segments of the anterior cerebral artery, represent a challenging subset of intracranial aneurysms. Due to their distal location and small size, DACA aneurysms have traditionally been managed with surgical clipping, though endovascular coiling is emerging as a viable alternative with recent advances in neuro-interventional techniques. **Materials and Methods:** This retrospective, single-center study was conducted at Dayanand Medical College & Hospital, Ludhiana, analyzing 15 cases of DACA aneurysms treated with endovascular coiling from June 2020 to January 2025. Data on patient demographics, clinical presentation, aneurysm characteristics, procedural details, and outcomes were collected. Pre-procedural assessments included computed tomography angiography (CTA) and digital subtraction angiography (DSA). Endovascular coiling was performed under general anesthesia without adjunctive devices such as stents, flow diverters, or balloons. Outcomes were evaluated using Glasgow Outcome Scale (GOS) scores and follow-up imaging. **Results:** The mean age of the cohort was 49.47 ± 10.68 years, with a slight female predominance (53.3%). Headache (73.3%) and altered sensorium (60%) were the most common presenting symptoms. All aneurysms were saccular, with most being solitary (86.7%) and located in the A3 segment (40%). The technical success rate was 100%, achieving complete or near-complete occlusion in all cases. Post-procedural complications included vasospasm (40%) and neurological deficits (40%), while favorable outcomes (GOS scores of 4 or 5) were achieved in 66.7% of patients. There were no cases of post-procedure meningitis or cerebral infarct needing decompressive craniectomy. **Conclusion:** Endovascular coiling is a safe and effective treatment modality for DACA aneurysms, demonstrating high technical success rates and favorable clinical outcomes. Despite the challenges associated with distal location and small parent arteries, endovascular techniques offer a minimally invasive alternative to surgical clipping.

KEYWORDS : Distal Anterior Cerebral Artery Aneurysms, Endovascular Coiling, Minimally Invasive Therapy, Long-term Outcomes.

INTRODUCTION

Distal anterior cerebral artery (DACA) aneurysms, located within the A2 to A5 segments of the anterior cerebral artery represent a rare subset of intracranial aneurysms, accounting for approximately 2% to 9% of all cases.[1,2] These aneurysms often exhibit unique clinical and anatomical challenges, including their frequent association with multiple aneurysms, high rupture rates at diagnosis, and a propensity for subarachnoid hemorrhage (SAH) and intraparenchymal hematoma (IPH) in ruptured cases.[2,3] The location of DACA aneurysms within the distal vascular distribution poses substantial obstacles to their treatment, primarily due to their small size, tortuous parent arteries, and proximity to critical neuroanatomical structures.[4,5]

Historically, the surgical management of DACA aneurysms through interhemispheric craniotomy and aneurysm clipping has been the preferred approach. However, this method is associated with considerable technical difficulties, including limited operative field, adhesions to the cingulate gyrus, and unfavorable orientation of the aneurysmal sac. These factors contribute to high perioperative morbidity rates, ranging from 12% to 25%.[3,4] With advancements in neuroendovascular techniques and devices, endovascular treatment has emerged as a viable alternative. Despite its minimally invasive nature, endovascular coiling of DACA aneurysms remains technically demanding, given the small caliber of the parent artery, the risk of procedural complicatiqons such as sac perforation, and the higher incidence of recanalization.[1,2,6]

Over the past two decades, numerous studies and case series have explored the efficacy, safety, and long-term outcomes of endovascular treatment for DACA aneurysms. The introduction of advanced techniques, such as stent-assisted coiling and flow-diversion devices like the Pipeline Embolization Device (PED), has significantly improved angiographic and clinical outcomes in complex cases.[1,5,7] Meta-analyses and single-center experiences consistently report high occlusion rates with endovascular therapy, although they underscore the need for meticulous patient selection and long-term follow-up due to the risk of recurrence.[5,7]

At Dayanand Medical College & Hospital, Ludhiana, neuro-endovascular procedures were initiated in 2020, with the first aneurysm coiling performed on June 18, 2020. Since then, 142 aneurysm coiling procedures have been successfully performed, including 15 cases of DACA aneurysm coiling as of January 2025. This institutional experience aligns with the global trend toward the adoption of endovascular techniques for DACA aneurysms, reflecting the ongoing evolution of treatment strategies for this challenging aneurysm subtype.

This study aims to present an overview of our center's experience with endovascular coiling of DACA aneurysms. By integrating the findings from the current literature and retrospective analysis of our cases, this research contributes to the growing body of evidence supporting the safety and efficacy of endovascular approaches in managing DACA aneurysms. Furthermore, it highlights the clinical and procedural nuances specific to this aneurysm subtype and underscores the importance of long-term follow-up to mitigate the risks associated with recanalization and recurrence.

MATERIAL AND METHODS

Study Design and Setting

This retrospective, single-center study was conducted at Dayanand Medical College & Hospital, Ludhiana, which initiated neuro-endovascular procedures in 2020. The study reviewed all patients who underwent endovascular coiling for distal anterior cerebral artery (DACA) aneurysms between June 2020 and January 2025. A total of 15 patients with confirmed DACA aneurysms were included in the analysis. Ethical approval was obtained from the institutional ethics committee, and all procedures adhered to established guidelines for human research and clinical care.

Patient Selection

The study included patients with angiographically confirmed DACA aneurysms located within the A2 to A5 segments of the anterior cerebral artery. Both ruptured and unruptured aneurysms were considered. Exclusion criteria included aneurysms managed

surgically, non-DACA aneurysms, and patients who did not complete follow-up or had incomplete medical records. Clinical data, including demographics, clinical presentation, comorbidities, and aneurysm characteristics, were extracted from hospital records.

Pre-Procedural Assessment

All patients underwent comprehensive pre-procedure imaging, including computed tomography angiography (CTA) and digital subtraction angiography (DSA), to confirm aneurysm location, size, and morphology. Clinical severity was assessed using the Hunt & Hess scale, Modified Fisher scale, and the World Federation of Neurosurgical Societies (WFNS) grading system. Patients were also evaluated for neurological deficits, Glasgow Coma Scale (GCS) score, and comorbidities.

Endovascular Procedure

Endovascular coiling was performed under general anesthesia by a team of Neurosurgeons trained in Neuro endovascular procedures. Systemic heparinization was used intraoperatively in all cases. Coiling was performed using a transfemoral approach with fluoroscopic guidance. No adjunctive devices such as stents, flow diverters, or balloons were used during the procedures. The number and type of coils used were determined based on aneurysm size and morphology. Intra-arterial nimodipine instillation was performed selectively to manage vasospasm.

Post-Procedural Management

All patients were monitored in the neurocritical care unit for at least 24 hours post-procedure. Neurological status was assessed regularly, and post-procedure imaging (CTA or DSA) was performed to evaluate the occlusion of the aneurysm and detect any complications, including vasospasm or residual aneurysm filling. Patients received standard postoperative care, including hydration and vasospasm prophylaxis.

Outcome Measures

Primary outcomes included the technical success of aneurysm coiling, defined as the ability to achieve complete or near-complete occlusion of the aneurysm. Secondary outcomes included procedural complications (e.g., vasospasm, hydrocephalus, or neurological deficits), GCS scores at discharge, and long-term outcomes assessed using the Glasgow Outcome Scale (GOS). Favorable outcomes were defined as GOS scores of 4 or 5.

Data Collection and Analysis

Data were collected retrospectively from patient medical records, procedural notes, and follow-up imaging. Statistical analysis was performed using descriptive statistics, with categorical variables expressed as frequencies and percentages and continuous variables as mean ± standard deviation (SD). Analyses were conducted using SPSS software.

RESULTS

Among the 15 patients included in this study, the mean age was 49.47 ± 10.68 years, with a slight female predominance (53.3%). The most common presenting symptom was headache, reported in 73.3% of cases, followed by altered sensorium (60%), and neurological deficits (46.7%). Vomiting and seizures were observed in 33.3% and 6.7% of patients, respectively. Hypertension was the most prevalent comorbidity, present in 60% of cases, while 26.7% had no prior medical history. The clinical presentation underscores the diverse and often severe symptomatology of DACA aneurysms, reflecting the potential complexity of their management.

Table 1: Demographics and Clinical Presentation

Variable	Frequency (n=15)	Percentage (%)
Sex		
Female	8	53.3
Male	7	46.7
Age (Mean ± SD)	49.47 ± 10.68	-
Clinical Symptoms		
Headache (Y)	11	73.3
Altered Sensorium (Y)	9	60.0
Vomiting (Y)	5	33.3
Neurological Deficit (Y)	7	46.7
Seizures (Y)	1	6.7
Comorbidities		
None	4	26.7
Hypertension (HTN)	9	60.0
Hypothyroid + HTN	1	6.7
Hepatitis C	1	6.7

All aneurysms in this cohort were saccular, with most being solitary (86.7%). The aneurysms were nearly evenly distributed between the left (40%) and right (46.7%) sides, while 13.3% had aneurysms on both sides. The majority of cases presented with Hunt & Hess Grade 3 (40%), and Modified Fisher Grade 1 (46.7%), while higher grades such as Modified Fisher Grade 4 were observed in 33.3%. The World Federation of Neurosurgical Societies (WFNS) grading system revealed that 73.3% of patients were categorized as Grade 1 or 2, indicating moderate severity. These findings highlight the complexity and variability in aneurysm presentation, which necessitates individualized treatment strategies.

Table 2: Aneurysm Characteristics

Variable	Frequency (n=15)	Percentage (%)
Aneurysm Type		
Saccular	15	100.0
Number of Aneurysms		
Single	13	86.7
Multiple	2	13.3
Side of Aneurysm		
Left	6	40.0
Right	7	46.7
Both	2	13.3
Hunt & Hess Grade		
Grade 1	4	26.7
Grade 2	4	26.7
Grade 3	6	40.0
Grade 5	1	6.7
Modified Fisher Grade		
Grade 1	7	46.7
Grade 2	2	13.3
Grade 3	1	6.7
Grade 4	5	33.3
WFNS Grade		
Grade 1	6	40.0
Grade 2	5	33.3
Grade 4	3	20.0
Grade 5	1	6.7

Endovascular coiling was performed in all 15 cases without the use of adjunctive devices such as balloons, flow diverters, or stents. Most aneurysms were located in the A3 segment of the left anterior cerebral artery (40%), while 26.7% had multiple aneurysms. The aneurysm size ranged from 2.5 × 2.2 mm to 6.5 × 4.5 mm. These results demonstrate that even challenging aneurysm locations and sizes can be effectively treated using meticulous coiling techniques, without reliance on additional devices.

Table 3: Procedure and Aneurysm Details

Variable	Frequency (n=15)	Percentage (%)
Balloon/FD/Stent Application		
Not Used (N)	15	100.0
CT Angiography Findings		
Ruptured Left A2 Segment Aneurysm	4	26.7
Ruptured Left A3 Segment Aneurysm	6	40.0
Ruptured Left A4 Segment Aneurysm	1	6.7
Ruptured Right A2 Segment Aneurysm	2	13.3
Ruptured Right A3 Segment Aneurysm	2	13.3
Multiple Aneurysms	4	26.7
Aneurysm Size (mm) Range	2.5 x 2.2 mm – 6.5 x 4.5 mm	

The number of coils used per procedure varied from 1 to 7, with 40% of cases requiring 3 coils. Two coils were used in 13.3% of cases, while 6.7% of patients required as many as 6 or 7 coils. The variability in the number of coils reflects the heterogeneity in aneurysm size and morphology, emphasizing the need for tailored procedural approaches to achieve optimal occlusion.

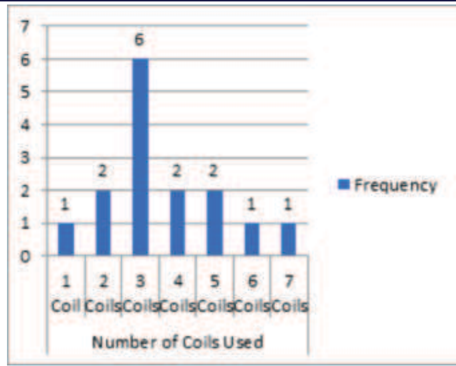

Figure-1: Aneurysm Coiling Data

Post-procedure outcomes were favorable in most cases. Neurological deficits were observed in 40% of patients, while vasospasm occurred in the same proportion. Only one patient (6.7%) experienced hydrocephalus requiring cerebrospinal fluid diversion, while there were no cases of post-procedure meningitis or the need for decompressive craniectomy. Intra-arterial nimodipine instillation was performed in one patient (6.7%) to address vasospasm. These results emphasize the overall safety and efficacy of endovascular coiling, with minimal post-procedure complications.

Table 4: Post-Procedure Outcomes

Variable	Frequency (n=15)	Percentage (%)
Neurological Deficit Post Procedure		
Yes	6	40.0
No	9	60.0
Vasospasm		
Yes	6	40.0
No	9	60.0
Post-Procedure HCP		
Yes	1	6.7
No	14	93.3
Intra-Arterial Nimodipine Instillation		
Yes	1	6.7
No	14	93.3
Post-Procedure Meningitis		
No	15	100.0
Need for CSF Diversion		
Yes	1	6.7
No	14	93.3
Need for Decompressive Craniectomy		
No	15	100.0

Pre-procedure GCS scores ranged widely from 4 to 15, with 40% of patients presenting with a score of 14. At discharge, the majority (66.7%) achieved a GCS score of 15, reflecting significant clinical improvement. Favorable outcomes, defined as GOS scores of 4 or 5, were observed in 66.7% of cases, with nine patients achieving complete recovery (GOS score of 5). These findings highlight the potential for good recovery with appropriate endovascular intervention, even in patients presenting with impaired neurological function.

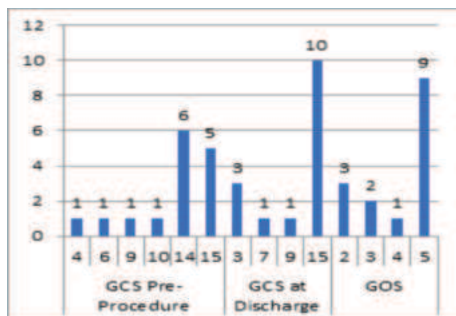

Figure-2: Glasgow Coma Scale (GCS) and Glasgow Outcome Scale (GOS)

Discussion

The present study reflects the evolving role of endovascular coiling in the management of distal anterior cerebral artery (DACA) aneurysms, a rare and challenging subset of intracranial aneurysms. By analyzing 15 cases of DACA aneurysms treated at Dayanand Medical College & Hospital, Ludhiana, this study adds to the growing body of literature highlighting the safety, efficacy, and limitations of endovascular approaches. Our findings align with and build upon prior research, offering insights into clinical presentations, procedural techniques, and outcomes while contextualizing our results with data from previously reported studies.

In our cohort, the mean patient age was 49.47 years, consistent with findings from Huang et al[2], who reported a mean age of 50 years among their DACA aneurysm cohort. The slight female predominance (53.3%) in our study also reflects the broader epidemiology of intracranial aneurysms reported in studies by Suzuki et al[5] and Liao et al[3]. Headache was the most common presenting symptom (73.3%), followed by altered sensorium (60%) and neurological deficits (46.7%), findings that parallel those of Suzuki et al[5], who documented similar symptom profiles, particularly in ruptured cases.

All aneurysms in our study were saccular in nature, with most being solitary (86.7%) and located in the A2–A3 segments. This pattern aligns with reports by Liao et al[3] and Huang et al[2], who noted that the majority of DACA aneurysms cluster around the A3 segment. Notably, 40% of aneurysms in our cohort were Hunt & Hess Grade 3, and 33.3% were Modified Fisher Grade 4, underscoring the severity of clinical presentations and the need for urgent management. Similar findings were reported by Petrov et al[6], who observed high morbidity in ruptured DACA aneurysms, particularly those with associated intracranial hemorrhages.

The technical success rate in our study was 100%, with complete or near-complete aneurysm occlusion achieved in all cases. These results are comparable to the findings of Suzuki et al[5], who reported a 97.6% technical success rate in their cohort of 49 DACA aneurysms treated with endovascular coiling. Similarly, Nossek et al[1] demonstrated the feasibility of deploying the Pipeline Embolization Device (PED) in small arteries, achieving complete occlusion in all cases without significant complications. However, unlike Nossek et al[1], we did not use adjunctive devices such as stents or flow diverters, relying solely on coiling, which further underscores the versatility of simple coiling techniques in carefully selected cases.

Post-procedure vasospasm occurred in 40% of our patients, a rate consistent with the 33.3% reported by Suzuki et al[5] in ruptured cases. Neurological deficits were observed in 40% of our cohort, aligning with Sturiale et al[7], who noted that DACA aneurysms have higher complication rates compared to aneurysms in other locations. Notably, our study recorded no cases of meningitis or the need for decompressive craniectomy, highlighting the relative safety of endovascular techniques in experienced hands.

Favorable outcomes, defined as Glasgow Outcome Scale (GOS) scores of 4 or 5, were achieved in 66.7% of our patients. This is in line with the findings of Huang et al[2], who reported favorable outcomes in 79.3% of their cohort. However, our cohort included patients with a higher proportion of severe clinical presentations (e.g., GCS $\leq$ 10 in 33.3% of cases), which may explain the slightly lower proportion of favorable outcomes. The need for long-term follow-up, particularly to monitor for recanalization, is emphasized in studies by Liao et al[3] and Suzuki et al[5], who both observed recurrence rates necessitating additional interventions in up to 20% of cases.

While our study focuses exclusively on endovascular management, it is important to compare these findings with the outcomes of surgical clipping, as highlighted by Furtado et al[4] and Ahmad et al[8]. Surgical approaches, while effective in achieving durable occlusion, are associated with significant morbidity due to the narrow operative field and challenges in controlling the parent artery. Endovascular techniques, on the other hand, offer a minimally invasive alternative, with shorter recovery times and reduced procedural risks, as demonstrated in our study and others.[9,10]

Limitations and Future Directions

Despite the promising results, our study is not without limitations. The small sample size and single-center design may limit the generalizability of our findings. Additionally, the relatively short

follow-up period precludes comprehensive assessment of long-term recanalization rates and outcomes. Future studies should focus on multicenter collaborations and longer follow-up to better understand the durability of endovascular treatments for DACA aneurysms.

CONCLUSION

Our findings reaffirm the efficacy and safety of endovascular coiling as a primary treatment modality for DACA aneurysms, even in the context of challenging anatomy and severe clinical presentations. Compared to surgical clipping, endovascular techniques offer a less invasive alternative with comparable or superior outcomes in many cases. However, the risk of complications such as vasospasm and recanalization necessitates careful patient selection, meticulous procedural execution, and vigilant long-term follow-up. By contributing to the growing evidence base, this study underscores the need for continued advancements in endovascular technologies and techniques to further improve outcomes in this complex aneurysm subset.

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