Original Article

Early Morbidity and Outcome After Clipping Versus Coiling of Anterior Communicating Artery Aneurysms: A Head-to-Head Analysis

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Abstract

Objective: Intracranial aneurysms are pathological enlargements of intracranial arteries that frequently manifest at arterial branching sites. Surgical intervention of the anterior communicating artery aneurysm may present technical difficulties owing to its irregular anatomical configuration, intricate haemodynamics, and unfavourable morphology that hinders successful clipping. Another treatment method is endovascular coiling of an aneurysm. Both treatment modalities are complementary rather than competitive in nature, owing to their respective strengths and limitations. This study aimed to compare the two treatment modalities.

Methods: This study was conducted to obtain local evidence and implement the results of this study to reduce complications and improve the outcome of surgery. Therefore, this experimental study was conducted at the Department of Neurosurgery, Punjab Institute of Neurosciences, Lahore, for 12 months. Sixty cases were included: 30 in each group, selected using non-probability consecutive sampling. Group A patients were subjected to clipping-based surgery. Patients in group B underwent an endovascular procedure utilizing coiling. Patients were observed for mortality and complications during their hospital stay, and the outcomes were followed up at 3 months.

Results: Patients who underwent clipping had a significantly higher rate of favourable outcomes (23 of 30; 76.7%) than those who underwent Coiling (7 of 30; 23.3%).

Conclusion: Surgical clipping is a promising treatment option for anterior communicating artery aneurysms with a good long-term prognosis compared to endovascular clipping. Clipping carries a higher risk of complications, such as surgical site infection, meningitis, and cerebrospinal fluid (CSF) leak. In contrast, endovascular coiling carries higher mortality and morbidity, with a higher rate of focal neurological deficits and poorer prognosis.

Keywords: Intracranial aneurysm, anterior communicating artery aneurysm, embolization, therapeutic, neurosurgical procedures, microsurgery.

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Introduction

Intracranial aneurysms represent a critical neurological pathology characterised by abnormal dilation of cerebral blood vessels, posing significant risks of rupture and subsequent subarachnoid haemorrhage. The aetiology of intracranial aneurysms is multifactorial and influenced by environmental factors, genetic predispositions, and comorbidities. Genetic circumstances, such as tissue disorders, including Marfan syndrome, Ehlers-Danlos syndrome, and ADPKD, are associated with increased susceptibility. Variable risk factors include smoking, hypertension, atherosclerosis of arterial walls, and aneurysm progression. Intracranial aneurysms are a prevalent condition, accounting for approximately 4% of all cases. Saccular, fusiform, dissecting, and mycotic aneurysms are the four distinct varieties, with saccular aneurysms being the most prevalent. A SAH is a calamitous occurrence that results in 25% mortality. The anterior communicating artery (AComA) is where intracranial aneurysms occur most frequently. In recent years, endovascular treatment techniques have been implemented to address ruptures of ACom artery aneurysms. However, microsurgical clipping remains the cornerstone of aneurysm management due to the comparatively low recurrence proportion of ruptures and fewer interventions needed after clipping.[1] The morbidity and mortality rates associated with clipping as a treatment option for aneurysms have been the subject of frequent studies. The International Study of Unruptured Intracranial Aneurysms (ISUIA) determined that the total morbidity and mortality ranged from 11.1%–13.7% and 10.1%–12.6%, respectively, 30 days and 1 year after microsurgical clipping. Durable residual neurological deficits, aneurysm recurrence, SAH recurrence, and ischaemic stroke caused by vessel occlusion constitute morbidity.[2] Mortality and morbidity ratios are considerably higher in cases in which an aneurysm ruptures before microsurgical clipping. A randomised controlled trial in 2002 affirmed that the morbidity and mortality rate following ruptured Acom artery aneurysms was 30.6%.[3] Acom artery aneurysms are responsive to endovascular coiling compared to the orthodox excision method. The potential examination of treatment by the endovascular approach (ATENA) study, which was published in 2008, included 649 patients from numerous centres in France and Canada who had 1,100 unruptured aneurysms.[3] They concluded that coiling is a practical treatment option for most patients due to its low morbidity and mortality rates.
Despite extensive research, direct head-to-head comparisons, especially evaluating the early morbidity and short-term outcomes after clipping versus coiling of AComA aneurysms, remain scarce. Many previous studies assessed aneurysms at multiple anatomical locations without isolating AComA pathology, even though

aneurysms at this site exhibit distinct anatomical and physiological characteristics that can influence treatment outcomes. Moreover, data from our regional population are scarce.
The objective of this study was to gather evidence on both procedures and determine which procedure is more beneficial in reducing mortality and morbidity in anterior communicating artery aneurysms and to implement the results in clinical settings in the future.

Materials And Methods

This quantitative study was conducted at the Neurosurgery Unit III, Punjab Institute of Neurosciences, Lahore, from January 2023 to November 2024, and was approved by the Institutional Review Board (AMC/PGMI/LGH/ARTICLE/Research No. /00/155/22/IRB/16/06/2022). After applying the inclusion and exclusion criteria, 60 patients were included in the study. Informed consent was obtained from all participants, and data were collected using a proforma.
Data were entered and analysed using SPSS version 26. The mortality and morbidity of the participants were documented during their hospital stay. Variables such as pre-operative clipping /coiling and post-operative clipping/coiling World Federation of Neurological Sciences (WFNS) grade in terms of favourable and unfavourable outcome frequency were analysed.[4] The chi-square test was used to analyse favourable and unfavourable outcomes based on pre- and Post-WFNS scores.
The inclusion criteria for this study were age between 18 and 65 years, both sexes, and a diagnosis of subarachnoid haemorrhage (SAH) caused by a ruptured aneurysm of the anterior communicating artery. Participants must be within two weeks post-ictus (onset of haemorrhage).
The exclusion criteria were as follows: patients with medical co-morbidities that made surgery or coiling unsuitable, and individuals with a WFNS grade of 5, indicating severe impairment and poor prognosis.
Favorable outcome: Improvement in one grade of the WFNS score after intervention.
Unfavorable outcome: Decline of one grade of the WFNS Score after intervention.

Results

The mean age was 44 years, with a predominance of females (41; 68.3%) over males (19; 31.6%).

Table 1. Comparison of outcome in Clipping vs Coiling

Outcome	Clipping (n=30)	Coiling (n=30)	Total (N=60)	
No improvement	4	10	14	
Favorable outcome	23	7	30	Pearson chi square =17.355
Unfavorable outcome	3	13	16	p-value=0.000
Total	30	30	60	

The p-value (0.000) indicates a statistically significant association between treatment type and patient outcomes. Patients who underwent clipping had a significantly higher rate of favourable outcomes (23 of 30, 76.7%) than those who underwent coiling (7 of 30, 23.3%). Coiling resulted in a much higher rate of unfavourable outcomes (13 of 30, 43.3%) than clipping (3 of 30, 10.0%). A higher number of patients in the coiling group (Group B) showed no improvement (33.33%) compared to 13.33% in the clipping group. The analysis of postoperative complications revealed that both treatments carry risks; however, the type and frequency of complications differed between the two interventions. Higher complications in the coiling group (Group B).

Table 2. Comparison of complications between Group A (Clipping) and Group B (Coiling)

Complication	Group A(n=30)	Group B(n=30)
Mortality	2 (6.7%)	3 (10.0%)
Intraprocedural rupture	5 (16.7%)	6 (20.0%)
Extra axial hematoma	3 (10.0%)	0 (0.0%)
Surgical site infection	4 (13.3%)	0 (0.0%)
Meningitis	1 (3.3%)	4 (13.3%)
CSF leak	3 (10.0%)	0 (0.0%)
Hydrocephalus	4 (13.3%)	7 (23.3%)
Hemiparesis	1 (3.3%)	8 (26.7%)
Cranial nerve deficit	2 (6.7%)	6 (20.0%)

Coiling is associated with a significantly higher rate of hemiparesis, suggesting a greater risk of neurological impairment; that is, 26.7% in coiling vs. 3.3% in clipping and hydrocephalus, 23.3% in coiling vs. 13.3% in clipping. As clipping is a more invasive surgical procedure, the risk of infection is understandably higher (13.3% in clipping vs. 0% in coiling), along with postoperative cerebrospinal fluid leakage (10.0% in clipping vs. 0% in coiling) and extraaxial haematoma formation (10.0% in clipping vs. 0% in coiling). Mortality in the clipping group is 6.7%, considerably lower than 10.0% in coiling. Intra-procedural rupture is 16.7% in clipping and 20.0% in coiling.

Figure 1: Acom aneurysm coiling (photo after consent form patient)

Discussion

At present, the medical literature spanning the past five years does not contain enough meta-analyses that compare the risks and benefits of endovascular coiling and neurosurgical clipping.[5] Surgical clipping and endovascular coiling are the two treatment modalities expected to prevent aneurysm rupture by stopping blood flow into the aneurysmal sac. Developing methods, such as blood flow diversion and intrasaccular movement disturbance, offer alternative methods for complex aneurysms and high-risk patients.[6] The prediction of the results of intracranial aneurysm is influenced by several factors, that is, the location, dimensions, and morphology of the aneurysm, as well as the age of the patient, timing of

involvement, and comorbidities. Although progress in indicative and beneficial modalities has shown better results, subarachnoid haemorrhage is still associated with considerable morbidity and mortality, underlining the importance of early detection and rapid intervention. Anatomical differences of the ACoA encompass a range of morphological topographies, including hypoplasia, fenestrations, and fetal-type shapes, which may influence its useful volume and vulnerability to compulsive circumstances.[7] Endovascular methods, microsurgical clipping, and flow diversion modalities are the cornerstone methods for managing ACoA-related pathologies, stressing the requirement for interdisciplinary collaboration and adapted patient management.

Figure 2. Intraoperative A-com aneurysm clipping. (consent taken from patient)

Surgical clipping remains a fundamental treatment modality for intracranial aneurysms, offering durable occlusion and lowering the risk of rebleeding and neurological deficits. Postoperative complications, such as vasospasm, hydrocephalus, and surgical site infections, may also impact patient recovery and necessitate prompt intervention.[8,9] Endovascular coiling has appeared as a leading treatment method for the management of intracranial aneurysms, including those situated in the AComA. Endovascular coiling of AComA aneurysms has established promising results in terms of practical achievement, aneurysm destruction, and long-term toughness. Studies have reported a high number of obstructions with coiling and low rates of recurrence and re-rupture. Although procedural problems, including coil displacement, thromboembolism, and vessel puncture, may occur and require prompt action.[9,10] Surgical clipping is typically favoured by large, complex, or wide-necked aneurysms, as well as in cases of ruptured aneurysms with mass effect or intraparenchymal haematoma. Compared to surgical clipping, endovascular coiling offers advantages, such as reduced invasiveness, shorter procedural times, and faster recovery. It is often preferred for smaller, ruptured, or unruptured aneurysms, and for patients with significant comorbidities or contraindications to open surgery. A multidisciplinary evaluation involving neurosurgeons, interventional neuroradiologists, and neurologists is crucial for optimal patient selection and treatment planning.[11] In a study published in 2021, Lee et al. examined the risk factors for perioperative ischaemia problems in patients with an aneurysm. It was found that perioperative ischaemia problems were substantially related to multilocular aneurysms. [12]

From this study, it is evident that although both treatment modalities have their share of intraoperative and postoperative complications, the clipping group yields a better clinical prognosis compared to that of coiling. Our study demonstrated that the endovascular coiling technique for the management of ruptured AComA aneurysms had higher mortality than surgical clipping. Clipping (group A) had an overall mortality of 6.7%, and coiling (group B) had an overall mortality of 10%, which is also supported by a previous meta-analysis of 17 studies involving 1489 patients. It showed a higher overall mortality in coiling (2.34%) than in clipping (1.8%).[13] The difference in values could be explained by a large difference in the sample size compared to our study. As an open surgical technique, clipping offers direct visualisation of the aneurysm and physical placement of the clips, which could explain these better outcomes. Direct mechanical sealing of an aneurysm in this procedure has been associated with complete closure and reduced need for retreatment.[14]

Our study showed that the clipping group showed favorable outcomes in 76.6% patients and unfavorable outcomes in 10% of patients. On the other side, coiling showed favorable outcomes in 23.3% of patients and unfavorable outcomes in 43.3% patients. This clearly shows better clinical outcomes in group A. A recent single-center study also showed similar results, with a higher rate of favorable outcomes (40%) after 6 months among clipping groups compared to the coiling group (23%). But this study also examined the long-term outcomes in these patients, which showed that clipping was associated with a higher rate of unfavorable outcomes (33%) after 5 years in comparison to coiling (17%).[15] It indicates better clinical prognosis immediately after surgical clipping compared to coiling, but further studies are warranted to study the long-term outcomes.

Both techniques carry the risk of complications. Clipping (group A) showed a higher incidence of infectious complications, meningitis (20%), and surgical site infection (13.3%) than coiling (group B). According to a recent meta-analysis comprising 637 patients, comparing the outcomes of coiling and clipping, there was no case of postoperative meningitis in either group.[16] Although this is not consistent with our study, surgical clipping involves a craniotomy and a breach of the blood-brain barrier. As evident from this study, this breach makes patients more prone to the risk of infectious complications.[17] These can include surgical site infection, sepsis, meningitis, and encephalitis. In contrast, endovascular techniques may be associated with fewer infectious postoperative complications.

In our study, a higher incidence of CSF leaks (10%) was demonstrated in the clipping group compared to the coiling group, which had no such complication, as also demonstrated by Gohar et al. in their study, which showed CSF leaks in 4.2% of patients in the clipping group, while no such complication occurred in the coiling group.[18] As surgical clipping is an invasive procedure involving craniotomy and surgical exposure, there is a possibility of inadequate dural closure, ductal injury, or postoperative dead space formation that could explain the potential for intraoperative and postoperative CSF leaks and haematoma formation. In contrast, coiling is a minimally invasive procedure with a low risk for these consequences. However, these complications do not pose a risk of mortality in patients.

Close monitoring and proper management with techniques, such as lumbar drainage, infection control to prevent meningitis, and dural closure if necessary, can lead to full closure.[19-21]

It was also demonstrated that endovascular coiling showed a higher rate of neurological deficits compared to clipping. This is in contrast to the literature, as various past studies and meta-analyses have shown that surgical clipping has a higher chance of producing either permanent or temporary neurological deficits, given the involvement of craniotomy and a greater chance of ischaemia or physical injuries leading to focal neurological deficits.[14,22,23] Further investigation is warranted.

The reopening and retreatment rates for endovascular coiling are comparatively higher, likely due to the limitations of this technique.[14,24] As it depends on the clotting caused by coils placed in the aneurysm to achieve blood flow occlusion, it is difficult to completely achieve this. The efficacy of endovascular coiling is also influenced by the anatomical features of the aneurysm. Features, such as a diameter > 10 mm, a larger dome, a wide neck, and a dome oriented posteriorly, have been associated with poorer outcomes and higher rates of retreatment after endovascular coiling.[25] Such anatomical features have comparatively less impact on the efficacy of surgical clipping.

Since both clipping and coiling have their pros and cons, it is a dilemma to choose between the two. The decision of the mode of treatment is heavily influenced by several other factors, which vary case by case. The patient's choice is the most important factor that determines the mode of treatment. Patients' age and overall health are also important factors. Younger patients are better surgical candidates and should be offered a surgical mode of treatment. In contrast, older patients with comorbidities are poor surgical candidates and can be offered endovascular coiling. As also noted previously, a larger aneurysm with specific anatomical features in an accessible location could be better treated with clipping.[25] Surgical clipping is very invasive and involves craniotomy. This may take four to six weeks of recovery. On the other hand, coiling takes a few days to weeks for patient recovery. Endovascular coiling is also a better option for patients with an inaccessible location of an aneurysm. Where there is a lesser risk of complications for long-term complications with endovascular coiling, there is a higher incidence of retreatment associated with it.

Future directions

Further multicentre investigations and trials are warranted to provide clearer evidence on the efficacy of the two treatment options. Long-term outcome assessments and comprehensive long-term complication analyses are necessary.

Limitations

We acknowledge that this study has certain limitations. Owing to its single-center nature, the study's results are limited for external validity and generalisability. The small sample size and shorter follow-up are also important limitations.

Conclusions

Surgical clipping offers a promising treatment option for anterior communicating artery aneurysms with a good long-term prognosis compared to endovascular clipping. Clipping carries a higher risk of complications, such as surgical site infection, meningitis, and cerebrospinal fluid (CSF) leak. In contrast, endovascular coiling carries higher mortality and morbidity, with a higher rate of focal neurological deficits and poorer prognosis.

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