

Pravesh Rajbhandari, MS
Department of Neurosurgery
Annapurna Neurological Institute and Allied Sciences,

Anish Neupane, MBBS, MD
Department of Radiology,
Annapurna Neurological Institute and Allied Sciences,

Saujanya Rajbhandari, Resident (MD PHD)
Department of Neurosurgery, Hyogo College of Medicine,
Nishinomiya, Hyogo, Japan

Pranaya Shrestha, MS
Department of Neurosurgery,
Annapurna Neurological Institute and Allied Sciences,

Samir Acharya, MS
Department of Neurosurgery,
Annapurna Neurological Institute and Allied Sciences,

Resha Shrestha, MS
Department of Neurosurgery,
Annapurna Neurological Institute and Allied Sciences,

Reema Rajbhandari, MD
Department of Neurology,
Annapurna Neurological Institute and Allied Sciences,

Avinash Sharma, MD
Department of Neurology,
Annapurna Neurological Institute and Allied Sciences,

Sagar Upadhya, Medical Officer
Department of Neurosurgery,
Annapurna Neurological Institute and Allied Sciences,

Pragya Dhungel, Biomedical Engineer
Department of Neurosurgery,
Annapurna Neurological Institute and Allied Sciences,

Tariq Matin, MD
Department of Neurointervention,
Narayana Superspeciality Hospital, Gurugram, Delhi

Basant Pant, MD, Phd
Department of Neurosurgery,
Annapurna Neurological Institute and Allied Sciences,

Address for correspondence:
Pravesh Rajbhandari, MS
Department of Neurosurgery,
Annapurna Neurological Institute and Allied Sciences,
Maitighar, Kathmandu, Nepal
Email: praveshreema@gmail.com

Date submitted: 12/8/2018

Date accepted: 28/8/2018

Initial experience with aneurysm coiling in Nepal.

The aim of this study is to show the result of aneurysm coiling despite the difficulty in initiating neurointervention in Nepal. It is a retrospective study where only aneurysm that has undergone coiling are taken from 2017 to 2018. A total of eleven patients (male: female = 1: 10) with aneurysm were treated with endovascular therapy. 9 cases were ruptured aneurysm while 3 were unruptured. 5 aneurysm were located in anterior circulation while 6 were located in posterior circulation. Out of eleven cases 4 were treated by simple coiling technique, while 2 underwent balloon assisted coiling, 3 stent assisted coiling, 1 pConus assisted coiling and 1 simple coiling and stent assisted coiling. Statistical analysis showed significant correlation between fisher grading scale with mRS score ($P=0.013$) suggesting lower fisher grade, and improved outcome similar to the result of prospective one year follow up of Barrow Ruptured Aneurysm Trial (BRAT) study. With limited resources aneurysm coiling was performed at ANIAS with similar results to literature.

Keywords: Aneurysm coiling, Balloon assisted coiling, Digital subtraction angiography (DSA), Modified Rankin Scale (mRS), Stent assisted coiling.

Neurointervention in Nepal is slowly picking its pace, the number of neurointerventionist who got their training from abroad are few, mostly pursuing their career from neurosurgery, neuroradiology and neurology.^{15,19} There are limited infrastructure, trained cath laboratory technician and nurses, resource availability for neurointervention, and facilities in Nepal in comparison to developed countries.

In this study we have summarized the series of aneurysm cases that have undergone simple coiling, balloon and stent assisted coiling (**Figure 1**).

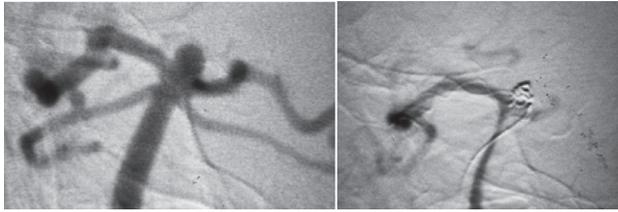


Figure 1: 54 years, female symptomatic and ruptured basilar tip aneurysm treated by stent assisted coiling. Follow up mRs score was 0.

Materials and Methods:

Data of patients undergoing aneurysm coiling from 2017 and 2018 were reviewed retrospectively. Patient demographics such as age, sex, initial Glasgow Coma Scale (GCS), Hunt and Hess scale (HHS), Fisher grading score, computed tomography (CT) / DSA / CT Angiography findings were obtained.⁵ Similarly, follow up data were also reviewed and mRS was obtained at the end of follow up period. Magnetic resonance angiogram (MRA) was also done to see compactness of coils.

Preoperative Preparation:

All patients underwent preanesthetic check up with general physical examination including laboratory investigation like complete blood count, bleeding profile, chest X- ray and electrocardiography. All patients were admitted in intensive care unit (ICU) with arterial line, nasogastric tube and catheterization. Dye allergy test was also performed. Patient scheduled to undergo elective stent device placement received in unruptured aneurysm dual antiplatelet therapy (DAT) aspirin 150mg, Clopidogrel 75mg BD for a minimum of 4 days before the procedure and DAT aspirin 150mg and clopidogrel 150mg in the morning of procedure.^{4,13} If the decision to perform stent assisted coiling urgently then DAT aspirin 300 and Clopidogrel 600 mg was given 4 hours before the procedure and if stenting is performed as an emergency bailout maneuver, we administered an intravenous bolus dose of glycoprotein IIb-IIIa inhibitor eptifibatide (180mg/kg).¹ Eptifibatide (2 mg/kg/minute) is continued as an intravenous drip for 4 hours after the procedure to allow the Clopidogrel to reach therapeutic level of platelet inhibition. In such case DAT aspirin 150 mg Clopidogrel 75mg post operatively.

Intraoperative Preparation:

All procedures were performed in general anesthesia with an arterial line. Infusion pumps were used to deliver nimodipine 15ml (0.2mg/ml) in 1000ml of normal saline, and heparin 0.5ml (5000IU/1ml) in 1000 ml of normal saline.²⁵ Special precautions were taken to prevent air

embolism. Access to femoral artery was performed with Seldinger technique with 7 French long femoral sheath with the guide of Teromo guide wire 0.035". First arterial line blood is sent for activated clotting time (ACT) and then flushed with 2500IU of heparin mixed with normal saline.¹ The tip is accessed up to common carotid artery and then to internal carotid artery (ICA). Angiography was then done to visualize the aneurysm and find a suitable working angle. After confirming aneurysm location by angiography, microcatheter (VASCO₊ 10, ID- 0.017") with support of intermediate catheter (FARGOMAX OD-6F, ID- 0.07") was navigated to aneurysm following the microguidewire (HYBRID OD-0.010" 12/14).

Different techniques were performed which included simple coiling, balloon assisted coiling and stent assisted coiling depending upon the aneurysm architecture and location.⁶ Triaxial technique was used for stent assisted coiling. ACT was regularly monitored every hour and kept at a range of 250 to 300. Post procedure the patient was extubated and shifted to ICU.

Postoperative management:

All patients were admitted in ICU for 3 to 10 days depending on the postoperative recovery. Mean Arterial Pressure (MAP) was closely maintained over 80 mm of hg. Inj. Cefazolin was given in 1st Post operative day following which Inj Ceftriaxone was continued till completion of regular antibiotic dosage. Similarly, dexamethasone was prescribed for 2 weeks. Aspirin was started post operatively for simple coiling , while addition of clopid (clopidogrel) or Tricagrelor as DAT in stent assisted coiling for three month, Eptifab 2 mg/kg/minute (eptifibatide) were used in stent assisted coiling if intraoperative clots were seen. Proton pump inhibitor, levetiracetam as prophylaxis for seizure was also used. Similarly, ted stocking and if necessary low molecular weight heparin were used as prophylaxis for deep vein thrombosis (DVT). Due to the unavailability of transcranial doppler, close neurological monitoring was done to see any signs of post subarachnoid hemorrhage vasospasm, large vessel occlusion or embolic stroke. Immediate DSA and hyperacute clot extraction was done in case of any thromboembolic episode.¹⁰ Minor postoperative problems such as hypo/hyponatremia, hypokalemia, respiratory tract infection and urinary tract infection were managed as per the standard guidelines.

Image Acquisition

Siemens Axiom artis U was used for neuroendovascular cases like coiling, DSA, clot extraction and embolization.²¹

It's high power generator was able to penetrate even dense anatomy and steep angulation feature allow us to view detail vascular structures clearly. However, this machine does not provide us with angular information of the c-arm. So, anteroposterior and lateral views along with additional multiple oblique views were obtained till proper working projection for aneurysm coiling is obtained.

It also has high heat capacity x-ray tube of 783kHU to avoid over heating issue. However, when two cases were carried out simultaneously with an hour gap in-between we encountered breakdown of the inverter board of machine. It has almost all the necessary features for coiling like road mapping, DSA, fluoroscopy, however lacks the 3D acquisition feature.

An optional integrated CD burner allows us to transfer examination results directly to CD for documentation and storage.

Results:

Very few patients with aneurysm choose to undergo endovascular coiling due to financial constraint and poor health insurance policy in Nepal. Also surgical clipping being the preferred choice of treatment in the country, patients hesitates to get treated with endovascular therapy. ANIAS is one of the high volume centers in Nepal with lot of neurosurgical cases including aneurysm being referred for treatment.

A total of eleven patients (male: female = 1: 10) with 12 aneurysm were treated with endovascular therapy. 2 of eleven patients were smoker. Seven patients were normotensive while two were hypertensive on medication and two were without medication. Only 1 of eleven patients was diabetic. 9 cases were ruptured aneurysm while 3 were unruptured. GCS was 13-15 (i.e. minor brain injury) in seven patients and 9-12 (i.e. moderate brain injury) in four patients. 5 aneurysms were located in anterior circulation while 6 were located in posterior circulation. Number of patients with aneurysm at different location is depicted in Table 1.

Out of eleven cases 4 were treated by simple coiling technique (Figure 2,3,5), while 2 underwent balloon assisted coiling(Figure 4), 3 stent assisted coiling, 1 pConus assisted coiling and 1 simple coiling and stent assisted coiling. One patient was harboring 2 aneurysms in which combined procedure of simple coiling (DACA) and stent assisted coiling was performed for (MCA) aneurysm. mRS was 0 for nine of the patients, however 6 for two patients.

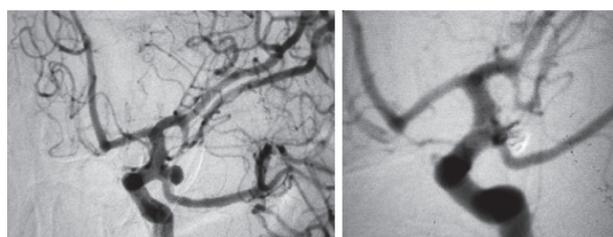


Figure 2: 63 years male symptomatic and ruptured left Pcom aneurysm treated with simple coiling. Follow up mRs was 0.

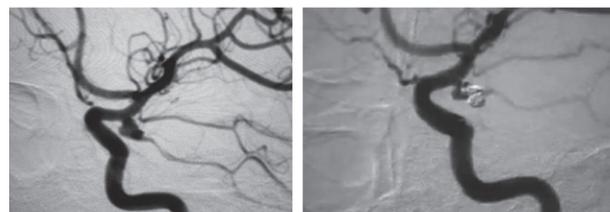


Figure 3: 36 years female symptomatic but unruptured left Pcom aneurysm treated by simple aneurysm coiling. Follow up mRs was 0.

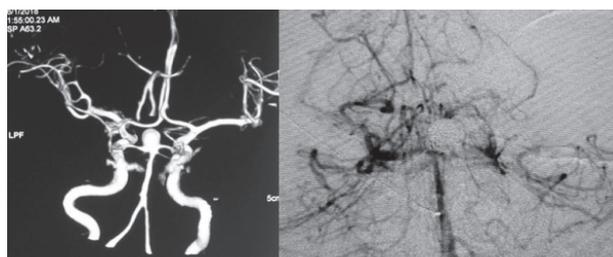


Figure 4: 45 years female symptomatic with ruptured basilar tip aneurysm treated with balloon assisted coiling. Follow up mRs was 0.

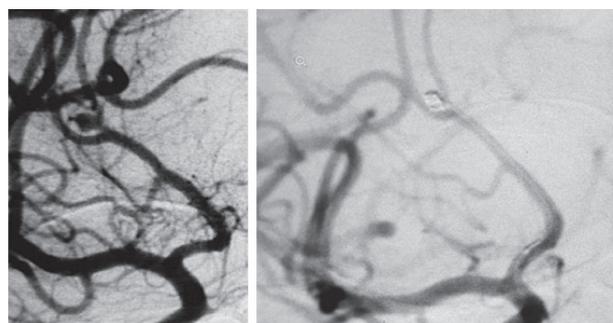


Figure 5: 45 years female with symptomatic and right DACA ruptured aneurysm treated with simple coiling. Follow up mRs was 0.

Similarly, following the statistical analysis of our study we found a strong correlation ($P= 0.013$) between fisher grading scale and mRS (Table 2). It indicated patient with lower fisher grade had improved mRS score in follow up. However, there was no significant correlation between

Table 1

Location of aneurysm	Number of patient
DACA	1
Acom	1
MCA	2
Pcom	2
PCA	1
SCA	1
Basilar top	2
DACA and MCA	1

Number of patients with aneurysm at different location. DACA – distal anterior cerebral artery; Acom- anterior communicating artery; MCA- middle cerebral artery; Pcom- posterior communicating artery; SCA- superior cerebral artery.

mRS and HHS (P=0.55). The one year follow up patient showed good coil compactness of aneurysm, with no residual or recurrence on MRA.

Postoperative complication

Patients were closely monitored in ICU. Not a single local puncture site complication was observed. In one patient with ACOM, aneurysm clipping was initially planned, however it couldn't be performed due to lot of adhesions between neck and bilateral A1 and A2. So, patient underwent balloon assisted coiling, however she developed thrombotic episode of ipsilateral M1 occlusion after 7 hours of procedure. Emergency thrombectomy was done using clot extraction device preset.¹⁰ Despite of initial recovery patient succumbed to vasospasm, cardiac arrest and death after one week. Another patient who received aneurysm coiling for giant PCA dissecting aneurysm developed obstructive hydrocephalus post operatively for which emergency external ventricular drainage (EVD) was performed. However, patient went into cardiopulmonary arrest.

Despite DAT on stent assisted coiling two cases developed thrombus in the stent for which we had to give intravenous Eptifab and Clopidogrel was changed to Ticagrelor postoperatively.

Discussion

In 1937 Waltar Dandy wrote "...An aneurysm at the circle of Willis is not entirely hopeless..." from which the era of clipping started. In March, 1990 Guido Guglielmi found detachable coil used for aneurysm coiling via endovascular technique in which the electricians, neurosurgeon and interventional neuroradiologist used combined effort to develop this device.^{7,8} Since 1990 till now different types of coils and delivery devices have

Significant correlation of Fisher grading scale with mRS score with P= 0.013

	Modified Rankin Scale	Fischers Grading Scale
Modified Rankin Scale	Pearson Correlation	.013
	Sig. (2-tailed)	.969
	N	11
Fischers Grading Scale	Pearson Correlation	.013
	Sig. (2-tailed)	.969
	N	11

Table 2

been developed. International subarachnoid aneurysm trial (ISAT) study flourished neuroendovascular technique.^{11,12} Latest prospective Barrow ruptured aneurysm trial 6 years follow up study (BRAT), result showed that aneurysm of posterior circulation is best for coiling and similar result in comparison to anterior circulation.^{22,26}

Neuroendovascular treatment is a minimally invasive technique for treatment of aneurysm.⁶ It has advantage for management of deep and ruptured aneurysm for which the cranial approach is difficult. Aneurysm dome neck ratio also known as aspect ratio is used to predict the treatment decision with adjunct techniques in the endovascular treatment of intracranial aneurysms. Aneurysm with aspect ratio > 1.6 usually do not require adjunctive techniques while aspect ratio of <1.2 almost always require adjunctive techniques.³ Adjunctive techniques like balloon assisted technique and stent assisted technique helps to prevent coil herniation into parent vessel in case of wide neck aneurysm.^{14,17,20,23,24} While the walls of the stent also produce a blood flow diversion effect away from the aneurysm, specially in the closed cell type, and act as a scaffold to promote endothelialization over the aneurysm neck.

The simultaneous use of a guiding sheath with an intermediate catheter and a microcatheter is called "the triaxial technique".⁶ This technique is used to navigate the microcatheter into the aneurysm and it provides more stability and control of microcatheter during embolization. Microcatheter should be positioned one-third to one-half the way into the aneurysm fundus to advance coils safely. Coil embolization is initiated using a 3 D designed framing coils which is subsequently followed by softer and more compliant filling and finishing coils. Coils are detached after confirming the patency of parent vessel and adequate packing of aneurysm. Adequate packing of coils help to form thrombi inside aneurysm thus preventing the blood flow into the aneurysm sac and

ultimately endothelializing the neck of the aneurysm. Care should be taken not to cause aneurysm perforation during microcatheter navigation and coil deployment.

Thromboembolic event is the most common complication that can be encountered during or after the procedure. This can be avoided by careful timing and dosage of administration of anticoagulation and antiplatelet therapy.

Among our case series cases were both asymptomatic and incidentally diagnosed aneurysm and also symptomatic and ruptured cases of aneurysm. Simple coiling, stent assisted coiling and balloon assisted coiling techniques were applied in individual patient on the basis of type of aneurysms. Two patients who were diagnosed with incidental aneurysm had good postoperative mRS score and short ICU stay while seven patients with ruptured aneurysm with fisher grade 2 had improved mRS score to 0 following few days of rehabilitation postoperatively.

Out of 3 stent assisted coiling cases 1 case succumb with vasospasm and embolus for which emergency clot extraction was performed. Two patients who were symptomatic, with ruptured aneurysm and fisher grade 3 at presentation had MRS score 6. Because of lack of platelet reactivity testing system and resistance to antiplatelet could not be assessed due to which Ticagrelor was given to prevent mishap from Clopidogrel resistance thrombus in two of our cases. Drugs like intravenous Nimodipine, Ticagrelor were not available. All the procedures were performed in uniplanar machine thus relying on increased clinical judgment during the procedure.²The follow up MRA showed good compactness of aneurysm coils and no recurrence or residual aneurysm.

After the successful initiation of neuroendovascular therapy in Nepal, proper treatment decision whether clipping or coiling can be made by treating physician and delivered to the patient in order to achieve good outcome and avoid morbidity and mortality.

Conclusion:

Neurointervention in Nepal is a new field; we should not be disheartened by either BRAT prospective study or the cost of the devices. We should focus on our team with good trained cathlab nurses, technicians, engineers and anesthesiologist. We should perform in latest biplanar machine but this is not available in all hospitals, so uniplanar machine with road mapping can also be performed but with careful precaution and clinical judgment. Many cases of aneurysm would prefer neurointervention to avoid aneurysm clipping because of its morbidity and the shear fear of surgery.

Acknowledgment:

We would like to thank Prof Dr Basant Pant with all his visions and ANIAS family not only providing the space to promote neurointervention but painstakingly sending the younger neuroradiologist and neurosurgeons to get their fellowship in neurointervention, Prof. Shinichi Yoshimura, MD Phd, Department of Neurosurgery, Hyogo College of Medicine for training them, Prof Gula Gal for giving us moral support and contributing devices, Dr Tariq Matin for his guidance, Krishna Sharma for providing us with the devices against all obstacles.

Anesthetists Dr Pradeep B, Dr Jitesh S, Dr Archana L, Dr Sambhu K OT nurses Shani M, Binita D, Ashmita S, Shristika T, Amrita S, CMA Pradeep Bhattraai have all given their best to achieve this goal.

Reference:

1. Ambekar S and Pandey P "A to Z in neurointerventional surgery: A primer for residents." **Neurology India** **63** (3): 419, 2015
2. Anxionnat R, Bracard S, et al. "Intracranial aneurysms: clinical value of 3D digital subtraction angiography in the therapeutic decision and endovascular treatment." **Radiology** **218** (3): 799-808, 2001
3. Brinjikji W, Cloft HJ, Kallmes DF: Difficult aneurysms for endovascular treatment: overdue or undertall? **AJNR Am J Neuroradiol**; **30**: 1513-17, 2009
4. Fiorella D, Thiabolt L, et al. "Antiplatelet therapy in neuroendovascular therapeutics." **Neurosurgery Clinics** **16** (3): 517-540, 2005
5. Fragatal and Canhao P "Imaging predictors of outcome in acute spontaneous subarachnoid hemorrhage: a review of the literature." **Acta Radiologica** **0**(0) 1-13, 2018
6. Gonzalez L. F, Albuquerque FC, et al. Neurointerventional techniques, **Thieme Medical Publishers**, 2015.
7. Guglielmi G. "History of the genesis of detachable coils: a review." **Journal of neurosurgery** **111** (1): 1-8, 2009
8. Guglielmi G, Vinuela F, et al. "Electrothrombosis of saccular aneurysms via endovascular approach: part 2: preliminary clinical experience." **Journal of Neurosurgery** **75** (1): 8-14, 1991
9. Ikawa F, MAbiko, et al. "Analysis of outcome at discharge after aneurysmal subarachnoid hemorrhage in Japan according to the Japanese stroke databank." **Neurosurgical review** **41** (2): 567-574, 2018

10. Kurre W, Aguilar-Perez M, et al. "Stent retriever thrombectomy of small caliber intracranial vessels using pREset LITE: safety and efficacy." **Clinical neuroradiology** **27** (3): 351-360, 2017
11. Molyneux A, Kerr R, et al. "International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomized trial." **Journal of stroke and cerebrovascular diseases** **11** (6): 304-314, 2002
12. Molyneux A. J, Kerr R.S, et al. "International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion." **The Lancet** **366** (9488): 809-817, 2005
13. Muraoka K, Sato Y, et al. "Effectiveness of Antiplatelet Drug Loading before Acute-phase Coil Embolization of Ruptured Cerebral Aneurysms." **Journal of Neuroendovascular Therapy** **12** (2): 75-80, 2018.
14. Park K.Y, Kim BM, et al. "Comparison between balloon-assisted and stent-assisted technique for treatment of unruptured internal carotid artery aneurysms." **Neurointervention** **11** (2): 99-104, 2016.
15. Paudel R, Phuyal S "Neurointervention in Nepalese Neurosciences Practice : The Need of the Hour." **Neuro** **3**, 2018
16. Perez P, Lukaszewicz A, et al. "Platelet activation and aggregation after aneurysmal subarachnoid hemorrhage." **BMC neurology** **18** (1):57,2018
17. Piotin, M, Blanc R, et al. "Stent-assisted coiling of intracranial aneurysms: clinical and angiographic results in 216 consecutive aneurysms." **Stroke** **41** (1): 110-115, 2010
18. Prestigiacomo C. J. "Historical perspectives: the microsurgical and endovascular treatment of aneurysms." **Neurosurgery** **59** (5 suppl 3), 2006
19. Roka Y. B. "Subspecialties in Neurosurgery: Are We Ready?" **Nepal Journal of Neuroscience** **15** (1): 1-2, 2018
20. Shapiro M, Becske T, et al. "Stent-supported aneurysm coiling: a literature survey of treatment and follow-up." **American Journal of Neuroradiology** **33** (1): 159-163, 2012
21. Siemens medical, Axiom Artis U: The little big one for universal angiography and cardiology applications. 6-10, 2005
22. Spetzler R. F, C. G. McDougall, et al. "The barrow ruptured aneurysm trial: 6-year results." **Journal of neurosurgery** **123** (3): 609-617, 2015
23. Spiotta A. M, Wheeler A.M et al. "Comparison of techniques for stent assisted coil embolization of aneurysms." **Journal of neurointerventional surgery** **4** (5):339-44, 2012
24. White A. C, Khattar N.K, Aljuboori Z.S, Jobiora JC and James RF. Basic Endovascular Techniques: Direct, Balloon-Assisted, and Stent-Assisted Coil Embolization. Intracranial Aneurysms, **Elsevier**; 329-356, 2018
25. Zenteno M, Moscote-Salazar L, et al. "Use of heparin in neurointervention: A review of the literature." **Romanian Neurosurgery** **20** (4): 369-374, 2013
26. Zhao J, Lin H, et al. "Current treatment strategies for intracranial aneurysms: An overview." **Angiology** **69** (1): 17-30, 2018