



A UNIQUE COMPARATIVE STUDY OF MICROSURGICAL CLIPPING AND ENDOVASCULAR COILING OF A RUPTURED CEREBRAL ANEURYSM DURING VASOSPASM.

Neurosurgery

Kunj Bihari Saraswat*	MS MCh Neurosurgery, Associate Consultant Neurosurgery, Max Super Specialty Hospital Dehradun, India *Corresponding Author
Ashok Gupta	MS MCh Neurosurgery, Senior Professor, Neurosurgery, Department of Neurosurgery, Sawai Maan Singh medical college Jaipur, India.
Virendra D Sinha	MS MCh Neurosurgery, Senior Professor, Neurosurgery, Department of Neurosurgery, Sawai Maan Singh medical college Jaipur, India.
Trilochan Shrivastav	MD DM Neurology, Senior Professor, Neurology, Department of Neurology, Sawai Maan Singh medical college Jaipur, India.

ABSTRACT

There was large number of comparative study between Clipping and Coiling. Our Unique Study compare both the technique in ruptured cerebral aneurysm with Radiological vasospasm >50%. Aims and objective was to compare both procedure and to evaluate clinical outcome of patients as Modified Rankin Scale at 24hr post op, at discharge and at 3month. Method : This was a prospective study included 28 patients who had ruptured intracranial aneurysm with Radiological Vasospasm as >50% luminal narrowing. These patients underwent surgical clipping (16 patients) or endovascular coiling (12 patients). Pre op Vasospasm Evaluated in these patients with Multi detector CT angiography. Clinical outcome determine with Modified ranking scale. Improvement in MRS score at 3 month was statistical significant in coiling group (P=0.035). There was significant improvement in MRS score at 3 month post coiling. We recommend further study with large sample size.

KEYWORDS

Clipping, Coiling, Significant Vasospasm

INTRODUCTION:

Subarachnoid hemorrhage (SAH) caused by intracranial aneurysm rupture is one of the most serious health-care problem¹. SAH is a fatal medical emergency and it require immediate intervention because about 12% of patients die before reaching Hospital, 33% patients die within 48 h and 50% patients die within 30 days of a SAH and around 50% of patient who survive suffer from permanent disability². Endovascular coiling has increasingly become an alternative procedure for surgical clipping in both ruptured and unruptured aneurysms in last decades^{3,4}. There is two modality of treatment one is surgical clipping and other is endovascular coiling. Both modalities have advantages and disadvantages which make them as complementary rather than competitive⁷. cerebral vasospasm and infarction being the two major causes of death and disability^{5,6}. Vasospasm frequently occurs within 2 weeks after the SAH, and its accurate diagnosis is essential to initiate appropriate therapy that may prevent ischemic insults^{8,9}.

Although vasospasm incidence ranges from 40% to 70% of aneurysmal SAH patients (angiographic vasospasm), it causes symptoms with delayed ischemic neurological deficits (symptomatic vasospasm) in only 17–40% of patients with aneurysmal SAH^{10,11,12,13}. Around 50% of patients with symptomatic vasospasm will develop ischemic infarct¹⁴.

There are various studies that compare incidence of vasospasm between surgical clipping and coiling^{15,16,17,18,19}.

In this study we included cases of ruptured aneurysm with vasospasm of intracerebral arteries >50% narrowing of large and medium size arteries or there segments on CT Angiography (moderate to severe grade of vasospasm) and performed clipping or coiling of ruptured aneurysm. The primary objective was to evaluate and compare the clinical outcome between clipping and coiling patients. There are large number of studies which compare clipping and coiling largest one is ISAT, but this study is unique as we include >50% vasospasm as entry point our study. there is no study till that who use inclusion criteria as angiographic vasospasm >50% in any medium or large size arteries and their segments.

MATERIALS AND METHODS:

Case Collection:

From Nov 2016 to Feb 2018, 28 patients with proven ruptured aneurysm and has >50% vasospasm in any predefined arteries on MDCTA underwent microsurgical clipping (16 patients) and coiling (12 patients) both in department of neurosurgery BMRC SMS medical

college Jaipur Rajasthan India. Each patients age, sex, aneurysm site and >50% vasospasm recorded and clinical status graded according to Hunt and Hess scale and WFNS grade. SAH was diagnosed with CT scan and then to evaluate Aneurysm and Vasospasm MDCTA were performed. For patient undergoing Endovascular coiling Vasospasm also confirm by Angiography during procedure. Intra-arterial nimodipine were during endovascular coiling and local infiltration of Papavarine was done during Microsurgical clipping. During post-op period hypervolaemic hypertensive haemodilution therapy was initiated to all patients and iv nimodipine used in some patients.

Study was approved by Office of the Ethics Committee S.M.S. Medical college and Attached Group of Hospital (no. 3101 MC/EC).

Consent was taken from patients or their relative before enrolment in study.

Inclusion criteria:

1. Age 18–60 yr.
2. Ruptured aneurysm.
3. Anatomical vasospasm >50% on CT Angio or DSA.
4. Patients of all clinical grade of SAH.
5. Subject is willing to conduct protocol-required follow-up visits.
6. An appropriate signed and dated informed consent.

Exclusion criteria:

1. Age <18 and >60 yr.
2. Un- Ruptured aneurysm.
3. Anatomical Vasospasm <50%.
4. Current participation in another investigation drug or device treatment study
5. Known hereditary or acquired hemorrhagic diathesis, coagulation factor deficiency.
6. Renal failure as defined by a serum creatinine > 2.0 mg/dl (or 176.8 μmol/l) or glomerular filtration rate (GFR) < 30.
7. Patients who requires hemodialysis or peritoneal dialysis, or who has a contraindication to an angiogram for whatever reason.
8. Suspicion of aortic dissection in case of coiling.
9. Patients with a comorbid disease or condition that would confound the functional and neurological evaluations and compromise survival or ability to complete follow-up assessments.

Assessment of Vasospasm:

MDCTA: MDCTA was performed with multidetector spiral C T

scanner Philips, Ingenuity. First we obtain non contrast scout image(120 Kv, 400 mA).then scanning range was planned from 1 cm below the foramen magnum to vertex. Iohexol (Omnipaque 300), was administered intravenously via an 18 gauge catheter positioned in an antecubital vein. The contrast medium was administered with a power injector at a rate of 3–4 mL/s. Repetitive scans (120 kV, 20 mAs, 0.5-second scanning time, 1-second interscan delay) were obtained at 10 seconds after start of contrast material injection. Parameters for the CT angiographic acquisition were 1-mm section thickness, 6-mm table feed per rotation, 0.5-second gantry rotation time, pitch of 6, 120 kV, and 200–280 mA. The entire examination, including acquisition of image data, took 15–20 minutes.

3D reconstruction:

The volumetric data so obtained were transferred to a workstation (RAPIDIA 3D;) for further processing. Transverse sections were reconstructed with a section width of 1.25 mm at an interval of 0.6 mm. Matrix size was 512 X 512, and the field of view varied between 20 and 22 cm, depending on patient size. Volume-rendered images (VRIs) were generated by using the software installed on the workstation.

Image Analysis and Grading of Vasospasm:

MDCTA images evaluate for vasospasm in intracranial arteries and each artery or its segment having luminal narrowing given one out of five grade according to degree of spasm as follow. Grade-0: No spasm, Grade-1: Mild spasm (<25% luminal narrowing), Grade-2: Moderate spasm (25–50% luminal narrowing), Grade-3: Severe spasm (51–99% luminal narrowing), Grade-4: Total occlusion.

Arteries and their segments analysed:

- Internal Carotid Artery.
- MCA and M1 and M2 segments.
- PCAP1 and P2 segments
- ACAA1 and A2 segments
- Vertebral Artery
- Basilar artery
- Other Artery – Posterior cerebellar artery, Superior cerebellar artery.

For patient underwent endovascular coiling vasospasm also confirmed by DSA during procedure.

Procedure: Patients with ruptured aneurysm with Vasospasm grade 3 or more offered endovascular coiling and microsurgical clipping. Both Procedure done in Department of neurosurgery S.M.S. Medical college Jaipur Rajasthan India.

ASSESSMENT OF SYMPTOMATIC VASOSPASM AND CEREBRAL INFARCTION Symptomatic vasospasm was defined as follows:

- new neurological deficit occurring between days 4 and 14 following aSAH;
- no other identifiable cause for neurological deterioration as demonstrated on CT scan,
- vasospasm on CT Angiography or cerebral angiography.

Cerebral infarction was diagnosed on CT scan as a newly detected focal hypodense region, comparing with previous CT Scan that was not attributable to intracerebral haemorrhage, EVD placement or other nonvascular cause.

Follow Up:

Follow up was performed in both the group during OPD visit and on telephonic interview up to 3 month. Clinical outcome was followed by using modified rankin scale(MRS). MRS obtain at the time of admission, 24 Hr Post-op, at time of discharge and At 90 days. MRS graded patient as 0 to 6 grade and poor outcome was defined as MRS 3 or more.

Statistical methods :

Data was entered in Microsoft excel software and analyzed using SPSS software (version 20.0). Continuous data was expressed as mean and standard deviation and count data was expressed as proportion. Count data was analyzed using fisher exact and chi square test and continuous data was analyzed using unpaired t test. Ordinal data was analyzed using Mann-Whitney Rank Sum Test and Friedman test. P value <0.05 was considered as significant.

RESULTS:

Total 28 patients enrolled in our study. Out of 28 patient 16(57.1%) patient underwent microsurgical clipping and 12 (42.9%) patient underwent endovascular coiling. Both procedure carried out by different and experienced team. Baseline characteristic were available for both group in table 1. Mean age at presentation was higher in coiling group with no statistical significance and was 48 ± 16.57 in coiling group and 43.87 ± 11.45 in clipping group. Male: Female ratio was 1:2 in coiling and 1.7:1 in clipping group. 3 patients have history of Hypertension out of those 1 patient (33.3%) was in coiling group and 2 patients (66.7%) were in clipping group. Other risk factor are mentioned in table 1. No significant difference was there among two group

In clipping group 62% patients were having 15 GCS at time of presentation in contrast to coiling where 83.3% patient were having GCS score 15 at presentation. 25% patient in clipping group and 8.3% in coiling group were have GCS between 8-10. 6.25% patient in clipping group were having GCS between 4-7. Hence patient with lower GCS were more in clipping group but there was no statistical significance difference between two group.

37.5% patient in clipping group and 16.7% patient in coiling group were having hunt and hess grade 4-5 (high grade). 8.3% patient in clipping group and no in coiling group was in grade 3 and 10% patient in clipping and 9% patient in coiling group were have H and H grade 1-2. Hence Patient with Higher grade were more in clipping group. This might explain the cause of high percentage of death in clipping group but there was no statistical significance.

Most common symptom was headache (75%) followed by vomiting (53.6%), Loss of Consciousness(39.3%), Motor Deficit(Limb weakness-10.7%), Vertigo(7.1%), Ptosis(3.6%). IVH on CT scan was present in 9 patients of those 6 were in clipping group and 3 were in coiling p (0.687).

Of 28 patient presented with ruptured aneurysm one patient had two aneurysm and one patient had three aneurysm hence total 32 aneurysm were there in our study. Of these 29 aneurysm (90.63%) were located in anterior circulation and 3 aneurysm (9.37%) located in posterior circulation. Arterial distribution of aneurysm have been mentioned in table 2.

Six (18.8%) aneurysm were <4mm, 23(71.9%) were between 4-10 mm, 3(9.1%) aneurysm >10 mm. The percentage of larger aneurysm was higher in clipping group. 10 patients (62.5%) but no statistical significance found.

Out of 32 aneurysm ten (31.25%) had neck size <4 mm and 22 aneurysm(68.75%) had neck size >4 mm with no statistical significance in both group. Anatomical property is shown in table 3.

All patient in study has vasospasm of large or medium size artery or its segment as decrease in lumen diameter >50%. Patients having vasospasm <50% not included in study. Of 16 patient in clipping group 4 patient (25%) had symptomatic vasospasm and 12 patients (75%) had asymptomatic vasospasm and in coiling group out of 12 patients 2 patient (16.7%) had symptomatic vasospasm and 10 patients (83.3%) patients had asymptomatic vasospasm p (0.673). All patients received hyper dynamic therapy in pre operative and peri-operative period and it was continue in postoperative period. On post operative period in clipping group 10 patient (62.5%) had symptomatic vasospasm and 2 patients (12.5%) had asymptomatic vasospasm and 4 patients (25%) did not show vasospasm in coiling group out of 12 patients 5 patient (41.7%) had symptomatic vasospasm and 1 patients (8.3%) had asymptomatic vasospasm and 6 patients (50%) did not show vasospasm p (0.393). Pattern of vasospasm is shown in table 4.

Out of 12 pt of coiling group two patient did not have vasospasm in CT angio but show vasospasm during DSA. Out of 16 pt of clipping group two patient did not have vasospasm in DSA but show vasospasm during CT angiography. Frequency of complication is shown in table 1 point 12 no statistical significance difference in frequency of complication between two group.

In coiling group patients with MRS score 2 were 10 (83.3%) and in clipping group were 8(50%) and patients with MRS score 5 were 2 (16.7%) in coiling group and 8(50%) in clipping group. There were no

patients with MRS score of 0,1,3 and 6 in both group at time of admission. Mean MRS score at admission in clipping group was 3.5 ± 1.549 and in coiling group it was 2.5 ± 1.168 P(0.142). Mean MRS score at 24hr post op in clipping group was 3.87 ± 1.5 and in coiling group it was 3 ± 1.348 P(0.169). Mean MRS score at discharge in clipping group was 4 ± 2.191 and in coiling group it was 2.75 ± 1.913 P(0.109). Mean MRS score at 3 month in clipping group was 3.81 ± 2.167 and in coiling group it was 2.33 ± 1.969 P(0.09). There was improvement in MRS with time in coiling group was statistically significant P(0.035) but there was no significant improvement in MRS in clipping group P(1.000) shown in table-6 and Figure 1. Difference in mean MRS score at three month from admission was 0.31 ± 1.922 in Clipping and was -0.167 ± 1.528 in coiling group P(0.377) table-6. 7 patient (43.8%) in clipping group needed ventilatory support and 2 patient in coiling group needed ventilatory support P(0.223). Need of tracheostomy was statistically significantly higher in clipping group. One patient (6.25%) in clipping group and 2 (16.7%) patients in coiling group require EVD P(0.56). 6 patient (37.5%) in clipping group needed tracheostomy and No patient in coiling group needed tracheostomy table-1 point-13. 7 patients (43.7%) in clipping and 3 (25%) patients in coiling group were deteriorated, 3 patients (18.7%) in clipping and 1 (8.3%) patients in coiling group had no change in MRS and 6 patients (37.5%) in clipping and 8 (66.7%) patients in coiling group were improved P(0.307). Improvement of MRS was more in coiling group but no significant difference found table-5.

Table-1: Baseline characteristic of patients enrolled in both group

SI no.	Charecterstic	Endovascular coiling	Surgical clipping	p value
	Age (years)	48 ± 16.57	43.87 ± 11.45	0.443
	Sex			
	Female	8 (66.6%)	6 (37.5%)	252
	Male	4 (33.33%)	10 (62.5%)	
	M:F Ratio	1:2	1.7:1	
	Hunt and Hess scale			0.282
	1-2	9 (75%)	10 (62.5%)	
	3	1 (8.3%)	0	
	4-5	2 (16.7%)	6 (37.5%)	
	WFNS grade			0.676
	1-2	9 (75%)	10 (62.5%)	
	3	1 (8.3%)	1 (6.25%)	
	4-5	2 (16.7%)	5 (31.2%)	
	GCS at admission			0.401
	15	10 (83.3%)	10 (62.5%)	
	11-14	1 (8.3%)	1 (6.25%)	1.000
	8-10	1 (8.3%)	4 (25%)	0.355
	4-7	0	1 (6.25%)	1.000
	Risk Factor			
	Hypertension	1 (33.3%)	2 (66.7%)	1.000
	Diabetes mellitus	1 (100%)	0	0.429
	Smoking	2 (25%)	6 (75%)	0.401
	Alcohol	1 (100%)	1 (100%)	1.000
	Duration from ictus to surgery			
	<7	4 (33.3%)	1 (6.2%)	1.000
	8-14	4 (33.3%)	6 (37.5%)	0.691
	>15	4 (33.3%)	9 (56.3%)	0.705
	Duration from ictus to surgery (Mean±SD)	12.25 ± 6.52	14 ± 7.483	0.524
	Duration of Hospital stay			
	<7	1 (8.3%)	1 (6.2%)	1.000
	8-14	6 (37.5%)	6 (37.5%)	0.702
	>15	5 (31.2%)	9 (56.3%)	0.704
	Duration of Hospital stay (Mean±SD)	13.33 ± 3.89	15.31 ± 5.62	0.306
	Complications			
	Rupture or Rebleed	1 (8.3%)	1 (6.2%)	1.000
	Infarction	3 (25%)	4 (25%)	1.000
	Hydrocephalus	2 (16.7%)	2 (12.5%)	1.000
	Meningitis	0	1 (6.2%)	1.000
	Monoparesis	0	1 (6.2%)	1.000
	Seizure	1 (8.3%)	0	0.429
	Dyselectrolytemia	0	2 (12.5%)	0.492
	Death	2 (16.7%)	6 (37.7%)	0.401
	Need of associated procedure			
	Ventilatory support	2 (16.7%)	7 (43.8%)	0.223
	Tracheostomy	0 (0%)	6 (37.5%)	0.024
	EVD	2 (16.7%)	1 (6.25%)	0.56

Table 2: Arterial distribution of Aneurysm

	Clipping n=20	Coiling n=12	'p' value (Fisher's exact test)
Anterior circulation	18 (90%)	11 (91.67%)	1.000
A COM	10 (50%)	6 (50%)	-
DACA	1 (5%)	1 (8.3%)	-
A1	1 (5%)	1 (8.3%)	-
A2	1 (5%)	1 (8.3%)	-
MCA	3 (15%)	0	-
ICA	2 (10%)	2 (16.7%)	-
PCOM	0	0	-
Posterior circulation	2 (10%)	1 (8.3%)	1.000
Basilar top aneurysm	2 (10%)	1 (8.3%)	-

Table 3: Anatomical property of aneurysm

	Neck Size		P value	Shape	Size			P value
	<4	>4			<4mm	4-10 mm	>10 mm	
Coiling n=12	4 (33.3%)	8 (66.7%)	1.000 (Fisher's exact test)	100% saccular	3 (25%)	9 (75%)	0	0.329 (Chi square test)
Clipping n=16	6 (30%)	14 (70%)		100% Sacular	3 (15%)	14 (70%)	3 (15%)	

Table 4: Pattern of vasospasm

	Pre op			Post op			
	Symptomatic	Asymptomatic	p value	Symptomatic	Asymptomatic	Absent	p value
Clipping (n=16)	4 (25%)	12 (75%)	0.947	10 (62.5%)	2 (12.5%)	4 (25%)	0.393
Coiling (n=12)	2 (16.7%)	10 (83.3%)		5 (41.7%)	1 (8.3%)	6 (50%)	

Table 5: Change in MRS at 3 Month

	Clipping	Coiling	P (chi square test)
Deteriorated	7 (43.7%)	3 (25%)	0.307
Unchange	3 (18.7%)	1 (8.3%)	
Improve	6 (37.5%)	8 (66.7%)	

Table 6: Mean MRS in both group and their difference

Mean MRS in both group:					
Procedure	MRS at admission (Mean±SD)	MRS at 24 Hr post OP (Mean±SD)	MRS at discharge (Mean±SD)	MRS at 3 month (Mean±SD)	P value (Friedman test)
Clipping (n=16)	3.5 ± 1.549	3.87 ± 1.5	4 ± 2.191	3.81 ± 2.167	1.000
Coiling (n=12)	2.5 ± 1.168	3 ± 1.348	2.75 ± 1.913	2.33 ± 1.969	0.035
P value (Mann-Whitney Rank Sum Test)	0.142	0.169	0.109	0.09	
Difference in mean MRS score in both group from admission:					
Clipping (n=16)		0.375 ± 1.5	0.5 ± 1.897	0.31 ± 1.922	
Coiling (n=12)		0.5 ± 1	0.25 ± 1.765	-0.167 ± 1.528	
P value (Mann-Whitney Rank Sum Test)		0.743	0.486	0.377	

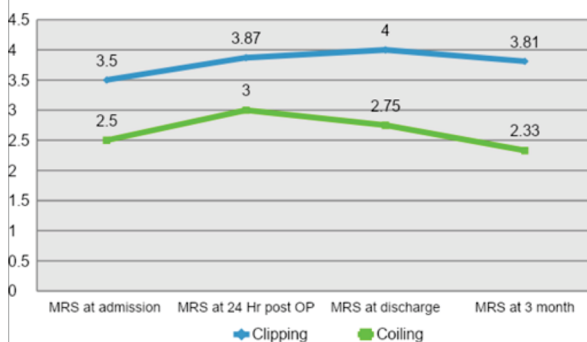


Figure1: Showing Mean MRS in both group at admission at 24 hour post op at discharge and at 3 month.

DISCUSSION:

This study has been done to compare the endovascular coiling with

surgical clipping in treatment of ruptured intracranial aneurysms with vasospasm >50% on CT Angiography or digital subtraction angiography (DSA). We use CT Angiography to detect cerebral vasospasm as a primary method. comparison done in terms of primary clinical outcome in terms of MRS at 24 hr post op, at discharge and at 3 month follow up, and secondary out come in terms of vasospasm , re-bleed, complication rate.

There was many trial those compare clipping and coiling largest trial was ISAT. According to ISAT endovascular coiling is the treatment of choice for ruptured intracranial aneurysms . however, long term follow up of ISAT suggested that patients younger than 40 year may have better outcome with surgical clipping^{3,22}.

Our study was not randomized thus the baseline characteristic of the patients was not similar between two groups. Female patient was more in coiling (66.7%) as compare to clipping (37.5%). patients with larger aneurysm were more in clipping group. Patients with poor clinical grade were more in clipping group. Most common aneurysm was A.Com in both group. Posterior circulation aneurysm were 3 and 2 of which were in clipping group.

When we compare MRS score in two group at time of admission was greater in clipping group which was not statistical significant. MRS at 24 hr post op was higher in clipping group but not statistical significant. MRS at time of discharge and at 3 month followup also was higher in post clipping group then coiling but this too does not have statistical significance. Although with Friedman test done in coiling group show statistically significant improvement in MRS score during followup but in clipping group worsening of MRS in clipping group was not statistically significant. Death rate was higher in clipping group (37.5%) as compare to coiling (16.7%)

Molyneux et al. 2143 patients recruited in ISAT in Europe centers reported 1 year outcomes for 1055 patients allocated to neurosurgical treatment, and 1063 patients allocated to endovascular treatment. In group of endovascular treatment patients, 23.5% (250) were dependent or dead at 1 year, compared with 30.9% (326) of patients underwent neurosurgery. In this study absolute risk reduction was 7.4% (95% CI = 3.6-11.2, P = 0.0001). The early survival advantage that was maintained up to 7 years and it was significant (P = 0.0300). The risk of epilepsy was lower in endovascular treated patients, the risk of late re-bleeding was higher²⁰.

In another study done on the ISAT database for comparing SAH recurrence , dependence and standardised mortality ratios between coiling and clipping, There was an increased small risk of recurrence in coiling while 5 years risk of death was higher in clipping significantly²¹.

In our study we use CT angiography with 3D reconstruction and cerebral angiogram as primary tool to identify Vasospasm.

Symptomatic vasospasm was defined as follows: (i) new neurological deficit occurring between days 4 and 14 following aSAH; (ii) no other identifiable cause for neurological deterioration as demonstrated on CT scan, (iii) vasospasm on CT Angiography or cerebral angiography. Cerebral infarction was diagnosed on CT scan as a newly detected focal hypo-dense region, comparing with previous CT scan that was not attributable to intra-cerebral haemorrhage, EVD placement or other nonvascular cause.

Studies on overall vasospasm rate asymptomatic as well as symptomatic done by Goddard et al (103 pt have vasospasm among 212 patients in clipping group and 38 patients have vasospasm among 80 patients in coiling group). 23 Hoh et al (277 pt have vasospasm among 436 patients in clipping group and 43 patients have vasospasm among 79 patients in coiling group) presented no significant difference between clipping and coiling with respect to overall vasospasm²⁴.

In our study as mention in inclusion criteria entry point of patient in study was >50% luminal narrowing in any medium and large size artery. Among them percentage of pre op symptomatic vasospasm was higher in clipping group (25%) as compare to coiling (16.7%) but no statistical significance was there. On post op percentage of pre op symptomatic vasospasm was higher in clipping group (62%) as compare to coiling (41.7%). No statistical significance was there in our study.

Some Study compare incidence of vasospasm among clipping and chilling suggest higher rate of infarct in coiling group²⁵.

Some study suggest higher incidence in clipping group²⁶.

In our study infarct rate was similar in both group (25% each).

In our study Rate of rebleed was higher in coiling group 8.3% as compare to coiling group (6.25%) but no statistical significance was there.

Occlusion rate of aneurysm was similar in both group with no statistical significance.

Hospital stay was higher in clipping group as compare to coiling but was not significant.

Limitations of the study:

Our study has small sample size and clinical grade of patients was not similar among two group. our follow up was also small. there was also dissimilarity in ruptured aneurysms percentage, aneurysm size, aneurysm location and MRS at the time of enrollment in the study.

Conclusion:

There were no significant difference in outcome at 24 hr post op, at discharge and at 3 month follow up between two group. There were no significant difference in incidence of vasospasm, re-bleed and occlusion rate. We recommend further study with bigger sample size and long term follow up for better evaluation.

Conflict of Interests

The authors declare no conflict of interest in this study.

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