

# ENDOVASCULAR TREATMENT OF RUPTURED INTRACRANIAL ANEURYSMS: IMMEDIATE RESULT AND LONG TERM FOLLOW UP.

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**Abstract:** Background: Endovascular treatment of ruptured intracranial aneurysms is being used increasingly and has evolved as an alternative to surgical clipping. However, its long-term efficacy has yet to be established. The purpose of this study is to discuss the immediate angiographic result and to identify factors that might be important in predicting initial efficacy of this treatment and a long term follow up to study the clinical and angiographic results of treated aneurysms. A total of 27 ruptured intracranial aneurysms in were treated with selective endovascular coil occlusion and the percentage of occlusion calculated. The shape of aneurysm rest was noted on the immediate post treatment and follow-up angiograms. Immediate and follow up clinical status was also noted using Glasgow outcome scale. The clinical and radiological changes on follow up were assessed and possible factors involved were analyzed. It is retrospective hospital based (tertiary teaching hospital) study. Of the 27 patients of intracranial aneurysms that underwent selective aneurysm coiling, good immediate outcome (Glasgow outcome scale 1 and 2) was seen in 24/27 (88.88%) cases. The narrow necked aneurysm showed good immediate angiographic result (90-100% packing) in all the cases 18/18(100%). Amongst the wide necked aneurysms, good packing (90-100%) was achieved in 7/9 (77.77%) cases. No subarachnoid hemorrhage was seen in any of the followed up cases of coiled aneurysms. A positive relationship was noted between the neck size and the immediate angiographic outcome. The long-term angiographic recurrences were found more often in large sized aneurysms. Endovascular treatment of intracranial aneurysms is a safe and effective treatment modality that offers protection from recurrent subarachnoid hemorrhage.

**Key words:** Aneurysm, subarachnoid hemorrhage, aneurysm coiling.

## INTRODUCTION

Intracranial aneurysms have a prevalence of 0.5% to 6% in adults and most of them are asymptomatic<sup>1,2</sup>. However, the most dreaded complication of intracranial aneurysm is rupture causing subarachnoid hemorrhage (SAH) with a mortality of 32-67%<sup>3</sup>. The aim of ruptured aneurysm treatment is exclusion of the aneurysm from circulation and prevention of rebleed. Endovascular treatment is being increasingly used for this purpose, however, long terms efficacy of this mode of treatment are still lacking. The purpose of this study is to discuss the immediate angiographic result and to identify factors that might be important in predicting initial efficacy of this treatment and a long term follow up to study the clinical and angiographic results of treated aneurysms.

## MATERIALS AND METHODS

This retrospective study was conducted in our department between May 1997 to July 2004. A total of 27 aneurysms in 27 patients (18 males, 9 females; age range: 46 to 72 years, mean: 57 years) were treated. SAH was noted in all patients. Sixty-two percentage aneurysms were in the anterior circulation and 37.03% in posterior circulation. Clinical presentation, Hunt and Hess grading and location of the aneurysms are given in Tables 1,2,3.

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**Table 1:** Presentation of Intracranial Aneurysms

CLINICAL PRESENTATION	NUMBER OF PATIENTS
1. HEADACHE	27
2. LOSS OF CONSCIOUSNESS	2
3. VOMITING	25

**Table 2:** Clinical Presentation of Ruptured Aneurysms

HUNT & HESS	NO. OF PATIENTS
GRADE 1	15
GRADE 2	5
GRADE 3	7
GRADE 4	0
GRADE 5	0
TOTAL	27

**Table 3:** Location Wise Distribution of Endovascularly Treated Intracranial Neuysms

LOCATION	COILING
ICA- COMMUNICATING SEGMENT	4
ICA- OPTHALMIC SEGMENT	3
ICA-MCA GRAFT	1
MCA BIFURCATION	3
A1-ACOM JUNCTION	6
BASILAR TOP	7
BASILAR TRUNK	1
PCA	2
TOTAL	27

## TECHNIQUE OF EMBOLIZATION

A complete clinical evaluation, hematology, blood biochemistry and coagulation profile was done in all patients. A diagnostic cerebral angiography were done in

each case to define the location of aneurysm in relation to the parent vessel, its anatomical location, geometric arrangement, size of the fundus and the neck and presence of thrombus within its lumen for taking decision regarding the mode of treatment (coiling vs parent vessel occlusion). In selected cases of complex anatomy, CT angiography was also done. Our institutional review board approved the procedure. Informed consent was taken from all patients. The anatomical location of aneurysm in ICA territory was done according to the Bouthillier classification of ICA segments<sup>4</sup>. In terms of geometry the aneurysm was classified into truncal, sidewall, bifurcation and terminal. In terms of the size the aneurysms were classified as small (<10mm), large (10-25mm) and giant (>25mm)<sup>5,6,7,8</sup>. The neck was classified as small  $\leq 4$ mm and large  $> 4$ mm<sup>6,9,10,11</sup>. All fusiform aneurysms were classified as wide necked. A detailed neurological evaluation was done in all and in cases of SAH an initial classification of patients according to Hunt and Hess scale and the Glasgow outcome scale were undertaken<sup>12,13</sup>.

Endovascular coiling was done under general anesthesia. Intravenous heparin was given at the dose of 50-100 IU/kg body weight to obtain an ACT between 2-2.5 times of baseline and maintained subsequently with hourly bolus of half the initial dose. With co-axial technique a microcatheter was introduced carefully into the aneurysm sac and a working projection obtained with a roadmap. In cases of unfavorable anatomy additional techniques like balloon remodeling were done and the aneurysm was coiled. The aim of coil placement was to pack the aneurysm as densely as possible without jeopardizing the adjacent normal vasculature.

The initial degree of occlusion is defined angiographically as 100% minus the amount of residual aneurysm filling. The angiographic outcome was broadly categorized on the basis of residual aneurysm filling on angiography<sup>14</sup>. Morphological results were also classified as: complete obliteration, dog-ear, residual neck and residual aneurysm.

The clinical outcome of patient immediately as well as on follow up was evaluated using the Glasgow outcome scale (1-complete recovery; 2-moderate disability but independent; 3-severely disabled but conscious; 4-persistent vegetative state and 5-death). A detailed neurological examination was done for the patient on follow up at an interval of three months for the first year and yearly thereafter in uncomplicated cases. Follow up angiography was advised for each patient between one to six months and at two years in cases with complete occlusion and yearly for those with residual neck. Follow up angiograms were compared with immediate post procedure angiograms and then assigned to one of the three categories: (a) Further thrombosis, when the amount of contrast agent filling the aneurysm decreased; (b) Unchanged, when a similar degree of aneurysm occlusion was found on multiple Angiographic results: Relation between immediate angiographic outcome and aneurysmal size are given in Tables 4. On post procedure angiograms, small sized aneurysms (< 10mm dome diameter) showed complete occlusion in 15/19 (78.94%) cases with stable occlusion noted in 17/19 (89.47%) of cases and progressive thrombosis seen in 1/19 (5.26%) case on follow up angiograms at 6 months and 1 year. In large sized aneurysms (10-25mm), complete occlusion was noted in only 4/8 (50%) cases on immediate post procedure angiogram with near complete occlusion seen in 1/8 (12.5%)

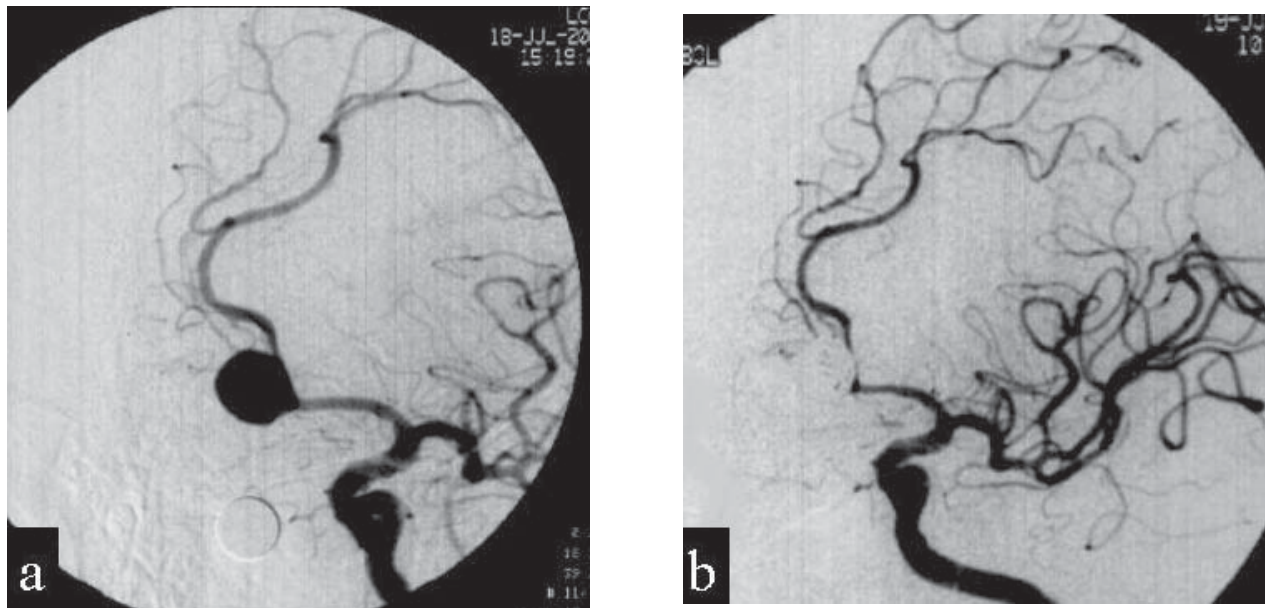


Figure 1: (a) Left internal carotid artery injection shows a giant aneurysm with wide neck. (b) Post coiling angiogram shows complete packing and total obliteration of the aneurysm.

**Table 4: Relationship Between Aneurysm Morphology And Results**

LUMINAL DIAMETER		NO. OF ANEURYSMS	IMMEDIATE RESULT			
<10mm	SMALL		19	PACKING %	NO.	ANGIO RESULT
			100%	12(63.15%)	CO	15(78.94%)
			90-99%	7(36.84%)	DE	3(15.78%)
			<90%	0	RN	1(5.26%)
10-25mm	LARGE	8	100%	3(37.5%)	CO	4(50.0%)
			90-99%	3(37.5%)	DE	2(25.0%)
			<90%	2(25.0%)	RN	2(25.0%)
NECK WIDTH		NO. OF ANEURYSMS	IMMEDIATE ANGIOGRAPHIC RESULT			
<4mm	NARROW		18	PACKING %	NO.	ANGIO RESULT
			100%	11(61.11%)	CO	15(83.33%)
			90-99%	7(38.88%)	DE	2(11.11%)
			<90%	0	RN	1(5.55%)
>=4mm	WIDE	9	100%	3(33.33%)	CO	4(44.44%)
			90-99%	4(4.44%)	DE	3(33.33%)
			<90%	2(22.22%)	RN	2(22.22%)

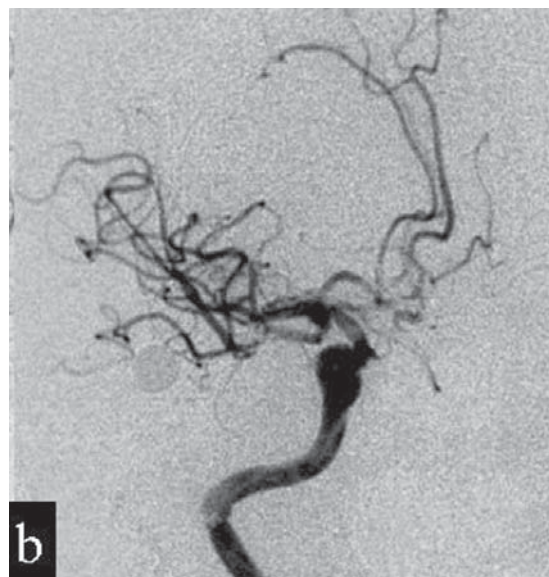
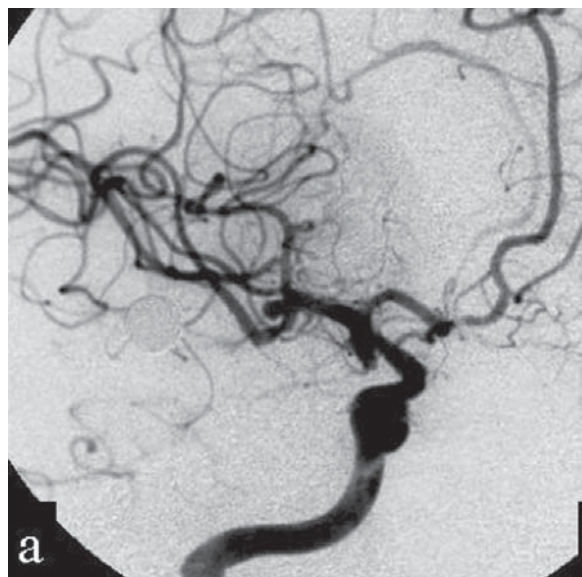


Figure 2: Right internal carotid artery injection shows a small narrow-necked middle cerebral artery bifurcation aneurysm. (b) Post-coiling angiogram shows total obliteration of the aneurysm.

case [Figure 1]. On follow up angiogram at 1 year, stable unchanged result was seen in only 4/8 (50%) cases with recanalization seen in 4/8 (50%) cases. Thus, the recanalization rate was much higher for large sized aneurysm (50.0%) than for small sized aneurysm (15.78%).

In case of narrow necked aneurysms (neck  $\leq$ 4mm), complete and near complete occlusion was seen in 15/18 (83.33%) cases [Figure 2] with 16 cases (88.88%) showing stable status and 2 (11.11%) showing recanalization on follow up angiogram at 1 year. Wide necked aneurysms showed complete and near complete occlusion in 4/9 (44.44%) cases with progressive thrombosis in 2 cases (22.22%) [Figure 3] and recanalization in 3 cases (33.33%) on follow up imaging. Aneurysm with wide neck showed slightly higher rate of recanalization (33.33%) compared to narrow necked aneurysms (11.11%).

### CLINICAL RESULTS

Clinical results at discharge are given in Table 5. Long term clinical follow up was available in 19/27 patients. The duration of follow-up in them was 1-6 years. The clinical

outcome of patient immediately as well as on follow up was evaluated using the Glasgow outcome scale.

Of the 27 cases of intracranial aneurysms that underwent selective aneurysm coiling, good immediate outcome (Glasgow outcome scale 1 and 2) was seen in 24/27 (88.88%) cases with poor clinical outcome in the remaining 3/27(11.11%) cases. The patients presenting with Grade 1 SAH had much better immediate clinical outcome (14/15) as compared to those presenting in Grade 2 or Grade 3 SAH (10/12) with good outcome in 93.33% and 83.33% cases respectively. Long-term follow up was available in 19/25 cases with good outcome (Glasgow outcome scale 1 and 2) in 17/19 (89.47%) cases and poor outcome in 2 cases. No rebleed was seen in any of the treated cases.

### COMPLICATIONS

Complications associated with endovascular treatment of intracranial aneurysms were classified as minor (leaving no neurological deficit or deficit not interfering with daily

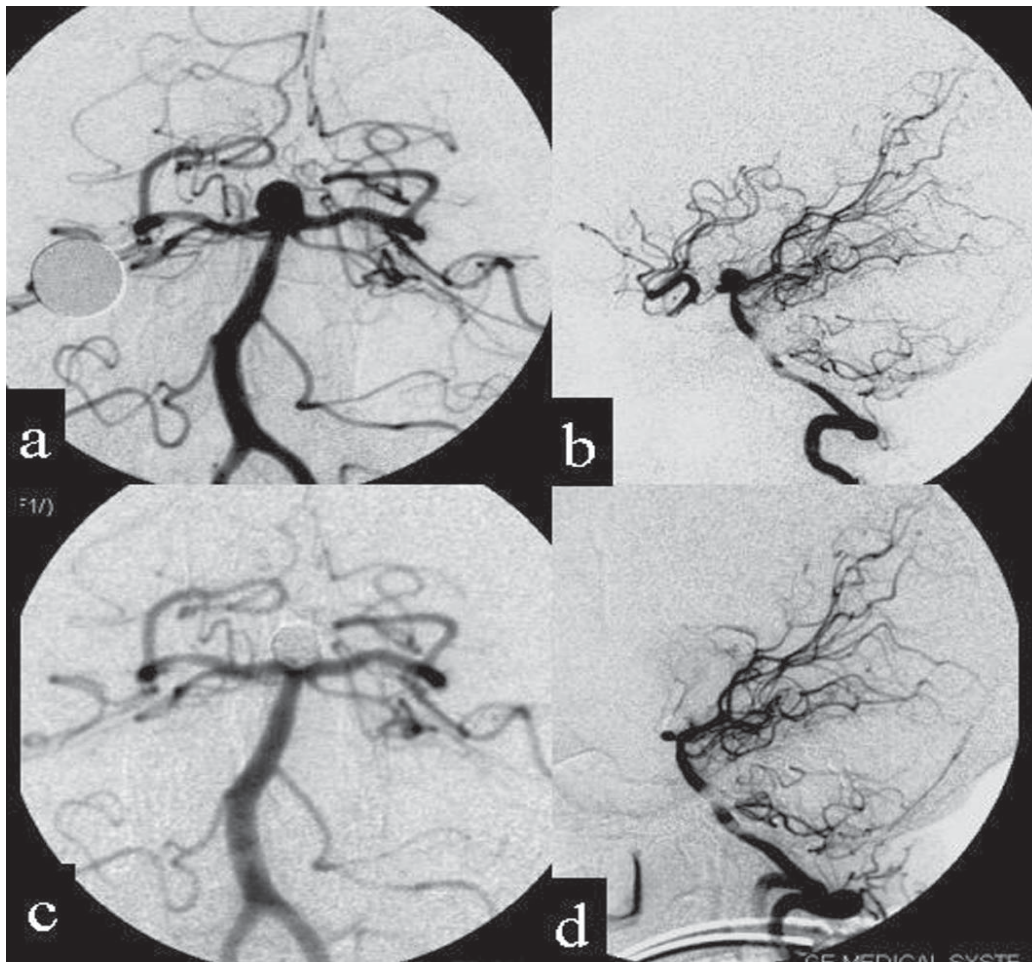


Figure 3: (a,b) Left vertebral artery injection anteroposterior and lateral views show a wide necked basilar top aneurysm. (c,d) Post coiling angiogram shows complete packing and total obliteration of the aneurysm. This was done with balloon remodeling technique. Note total luminal preservation of both posterior cerebral arteries

**Table 5: Relationship Between Severity Of SAH , FISHER GRADE on CT and Clinical Outcome at Discharge**

HUNT & HESS	No of patients	Glasgow outcome scale	No of patients
Grade 1	15	1	12 (80%)
		2	2 (13.33%)
		5	1 (6.66%)
Grade 2	5	1	3 (60.00%)
		2	4 (80.0%)
Grade 3	7	1	3 (42.85%)
		2	2 (28.57%)
		4	1 (14.28%)
		5	1 (14.28%)
FISHER CT GRADE	No of patients	Glasgow outcome scale	No of patients
Grade 1	3	1	1 (33.33%)
		2	2 (66.66%)
Grade 2	16	1	10 (62.50%)
		2	5 (31.25%)
		5	1 (6.25%)
Grade 3	1	5	1 (100%)
Grade 4	7	1	5 (71.42%)
		2	1 (14.28%)
		4	1 (14.28%)

activities) and major (leaving persistent neurological deficit or death). Patients having minor complications were successfully thrombolised and had no deficit. Aneurysm rupture during coiling was noted in 1 patients leading to death. Another patient developed post coiling thromboembolism and massive MCA infarct and died subsequently. Rest one patient had coil prolapse and partial occlusion of parent artery and had aphasia and hemiparesis. All the complications happened in our early cases.

## DISCUSSION

The goal of aneurysm treatment remains exclusion of aneurysm sac and neck from circulation and endovascular treatment is being increasingly used for this purpose. After introduction of endovascular treatment of intracranial aneurysms, there was a tendency to refer posterior circulation aneurysms for coiling in many centers considering the difficulty in treating those aneurysms by open surgery<sup>16,17,18</sup>. However, with refinement in endovascular techniques and better outcomes, the referral base has widened so that the subsequent studies showed inclusion of more number of anterior circulation aneurysms<sup>14,19,20</sup>. This coincided with the frequency found in our series for the anterior and posterior circulation aneurysms with the frequency of basilar bifurcation aneurysms and ICA aneurysms that were selected for coiling being 37.03% and 62.96% respectively.

In 2002, the American Heart Association formed a strict protocol for follow-up of endovascularly treated aneurysms<sup>21</sup>. Sluzewski et al found no benefit of 18 month follow up angiography in patients with complete or near complete aneurysm occlusion at 6 months<sup>22</sup>. In our patients, follow up angiography was advised for each patient between one to six months followed by one at two years in cases with complete occlusion and yearly for those with residual neck. Earlier follow up angiograms were done in case of an enlarging residual neck. Various imaging modalities are tried for following up these aneurysms, but DSA remains best to detect regrowth<sup>24,25,26,27</sup>.

The narrow necked aneurysm showed good immediate result (90-100% packing) in all the cases (18/18-100%) with complete occlusion in 15/18 (83.33%) cases. Amongst the wide necked aneurysms, good packing (90-100%) was achieved in 7/9 (77.77%) cases with complete occlusion in 4/9 (44.44%) cases. A statistically significant relationship was noted between the neck size and the degree of packing and immediate angiographic outcome. These results are well established and correspond to that of Zubilaga et al and Bavinzski et al<sup>23,28,29</sup>. Hope et al attempted to identify factors that might be important in predicting success both at the time of treatment and at the time of follow up angiography. They found that the only factor to achieve significance in predicting success at the time of treatment was neck size (P = 0.002, with 86% success for aneurysm neck <=4mm and

50% success for aneurysm neck >4mm)<sup>30</sup>.

In our study complete occlusion on follow up angiogram at 1 year was noted in 16/19 (84.21%) small sized aneurysms and 4/8 (50%) large and giant aneurysms. Satisfactory degree of occlusion (90-100%) was achieved in 15/19 (78.94%) cases of small sized aneurysm and 4/8 (50%) cases of large sized aneurysms in the immediate post procedure period. A statistically significant relation was established between the size of the aneurysm and the immediate angiographic result with a Pearson chi square value of 0.004. These results are comparable to that of Kuether et al. and Vineula et al.<sup>5,6</sup>

Initial and long-term follow up angiograms were compared in 19/25 (76.0%) cases of coiled intracranial ruptured aneurysms. Complete and near complete occlusion was seen in 14/19 (73.68%) cases with a stable result in 50% cases and recanalization seen in 26.31% cases over the follow up period. The results were comparable to other previous studies<sup>6,11,31,32</sup>.

Shin et al. retrospectively reviewed 18 consecutive patients who presented with acutely ruptured aneurysms and were in very poor neurological condition and who were treated with one-stage embolization and achieved promising results by using one-stage embolization to prevent ultra-early rebleeding<sup>34</sup>. Birchall et al. analysed the technical and clinical outcome in elderly patients receiving endovascular treatment for acutely ruptured intracranial aneurysms and concluded that endovascular coiling is an effective means of treating acute subarachnoid hemorrhage in grade I and II elderly patients<sup>35</sup>. In our series, no case of rebleed was seen in the followed up cases of treated aneurysms, however, it is the major concern for interventional treatment<sup>19</sup>. The International Subarachnoid Aneurysm Trial (ISAT) had compared randomly the surgically treated versus endovascularly treated ruptured intracranial aneurysms. The relative and absolute risk reductions in dependency or death in that trial after allocation to an endovascular versus neurosurgical treatment were 22.6% and 6.9% respectively. Rebleeding occurred in 2.6% of patients who underwent coiling or attempted coiling and in 1.0% of those who underwent surgery or attempted surgery<sup>19</sup>. But, with expertise we can prevent rebleed in all the endovascularly treated aneurysms as we have seen in this series.

Raymond et al evaluated retrospectively 501 aneurysms in 466 patients treated using detachable coils over a period of ten years for long-term angiographic recurrences. Recurrences were found in 33.6% of treated aneurysms that were followed up. Variables determined to be significant predictors ( $P < 0.05$ ) of a recurrence-included aneurysm size  $\geq 10$  mm, treatment during the acute phase of rupture, incomplete initial occlusions, and duration of follow-up<sup>23</sup>. Thornton et al presented a meta-analysis of 1397 patients, of who 1370 underwent postoperative angiography demonstrating 1569 clipped aneurysms Residual filling was found in 82 aneurysms (5.2%) on immediate postoperative angiography<sup>33</sup>. Our result is comparable to them. All our

complications were seen in our early cases and that reflects our learning curve in treating these lesions. The long-term angiographic recurrences were found more often in large sized aneurysms than small sized ones. The long-term stability of the coiled mass is also related to the neck size, presumably because hemodynamic forces are able to act on a larger surface area of the coil ball at the neck of the aneurysm. Although our study represents the effectiveness of endovascular treatment in ruptured aneurysms, it has its limitations. It lacks the prospective randomization of a clinical trial and the limited patient population in each group may lack the power to demonstrate the real effectiveness and complication rate of the procedure in them. In our study experienced operators have performed the procedures. It may be a clinically relevant limitation as in practice, the level of experience varies dramatically. Finally, prospective randomized controlled trials may assist in clarifying the uncertainties that continue to surround the techniques and effectiveness of the procedure in different types of lesion.

## CONCLUSION

A positive relationship was noted between the neck size and the immediate and long-term angiographic outcome. Long-term angiographic recurrences were found more often in large sized aneurysms. No case of rebleed was seen in the followed up cases of coiled aneurysms. Endovascular treatment of intracranial ruptured aneurysms is a safe and effective treatment modality and even partial occlusion gave good protection from rebleed.

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