Functional Outcome of Microsurgical Clipping Compared to Endovascular Coiling

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SUMMARY

Endovascular coiling has been used increasingly as an alternative to neurosurgical clipping for treating subarachnoid hemorrhage secondary to aneurysm rupture. In a retrospective cohort review on the treatment methods of aneurysm rupture in Hospital Kuala Lumpur over the period of five years (2005-2009) a total of 268 patients were treated. These patients were broadly categorized into two groups based on their treatment mode for ruptured aneurysms. Statistical analysis was determined using Chi-Square tests to study these associations. In our study, 67.5% of patients presented with Good World Federation of Neurosurgical Societies (WFNS) grade (WFNS1-2) while 32.5% patients presented with Poor WFNS prior to intervention. In our outcome, it was noted that 60.4% had good functional outcome (mRS grade 0-2) as compared to 39.6% patients who had poor mRS(modified rankin scale) outcome (mRS 3-6). In the good WFNS group, 76% of patients in clipping group had a good mRS outcome while, 86.5% patients in coiling group had good mRS outcome (p=0.114). In poor WFNS presentation, it was noted that in 77.3% patients in clipping group, had poor mRS outcome. Similarly with poor WFNS presentation, 83.3% of patient in coiling group had poor outcome. (p=1.00). Hence when we control the WFNS group, there was no significant association between treatment group (clipping and coiling) and mRS outcome at 6 months. The outcome of patient is determined by initial clinical presentation (WFNS grade) and influenced by requirement of Extraventricular drain (EVD) in presence of hydrocephalus, CSF infection and pneumonia. Therefore the decision regarding treatment option needs to be individualized based on the presentation of the patient.

KEY WORDS:
Subarachnoid haemorrhage, ruptured aneurysm, microsurgical clipping, aneurysmal coiling, WFNS

INTRODUCTION

Cerebral aneurysms are the fourth leading cause of cerebrovascular accident and account for 5–10% of all strokes[1]. There are various treatment options available for ruptured aneurysms including surgical and endovascular means.

Until recently, microsurgical clipping was the most popular treatment[2] for aneurysm treatment. Microsurgical clipping involves the exclusion of re-rupture with a certainty of approximately 98%[3]. However in the past decade, endovascular coiling has grown in popularity as an alternative to clipping. Endovascular coiling acts to obstruct the aneurysmal lumen with a detachable coil, to provoke secondary thrombosis of the aneurysm.

The definite method of treatment remains debated with conflicting views being constantly published. In addition there is a growing body of evidence suggesting that the most important causal factor for the neuropsychological sequelae of aneurysmal subarachnoid hemorrhage (SAH) is the hemorrhage itself and associated secondary brain damage, rather than the location of the aneurysm or treatment methods[3]. As such, we reviewed the outcome of aneurysm treatment in our centre as both methods of treatment are being practiced here.

We performed a retrospective cohort review on the treatment methods of aneurysm rupture in Hospital Kuala Lumpur over the period of five years (2005-2009). The purpose of this study was to evaluate the outcome of patients with rupture aneurysm who had been treated surgically with clipping or endovascularly with coiling. A total of 268 patients who fulfilled the inclusion criteria were recruited for this study. Their case notes, radiology reports and films were studied specifically on methods of treatment, clinical presentation (WFNS grade[4]) prior treatment, Computer Topography (CT) Fisher Grade of SAH, angiographic site of aneurysm, clinical vasospasm, requirement of Extraventricular (EVD) and shunt, pneumonia, Cerebrospinal fluid (CSF) infection and subsequent recovery to independence, morbidity and mortality. Apart from that, demographic data including age, gender, ethnicity and duration of illness were also recorded. Statistical analysis (Chi-square and Fisher's exact test) was then performed to determine the association between treatment methods and good functional outcome, morbidity and mortality

MATERIALS AND METHODS

This was a retrospective cohort review on the patients who were treated for ruptured aneurysm in Hospital Kuala Lumpur over period of five years (2005-2009).The inclusion criteria includes patients of both sexes with ruptured aneurysms of all sizes which were angiographically diagnosed and underwent coiling or clipping. Patients who had traumatic SAH, arteriovenous malformation, mycotic aneurysm, negative angiography and who refused treatment or with medical conditions that did not benefit from any intervention were excluded.

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Sample size was calculated using PS software (Dupont and Plummer 1997)[5]. The level of significance (α) is 0.5 and Power of study (1-β) is 0.8. The calculated minimal sample size was 170 patients. The ICU/HDU admission record of patients name, hospital registration number, identity card number, diagnosis, admission date and ICU/HDU discharge date were traced from record office. Patients' records, notes and films were traced and studied. Those patients who fulfilled the criteria were considered as the sample of this study. Their clinical presentation was determined by World Federation of Neurosurgical Societies grade (WFNS 1-6). This was further dichotomized to Good WFNS (WFNS 1-2) and Poor WFNS (WFNS 3-5)[6]. Patients who were followed up at six months were assessed using modified Rankin Scale (mRS) score[7]. mRS scores were dichotomized into good outcome (mRS 0 to 1) and poor outcome (mRS 2 to 6). The record trace was approved by the Hospital Director and cleared by USM ethical committee.

Data analysis was done using Statistical Package for Social Sciences (SPSS) version 17.0. Most of the data were categorical except for the age. Univariable analysis was done using chi-square or Fisher's exact test to identify clinical outcome associated with the mode of treatment. The P values obtained from the univariable analysis were used as the basis for determining the significant variables which were analyzed by multiple logistic regression analysis. Backward multiple logistic regression analysis was performed to assess the significant clinical variables associated with the outcome. The level of significance was set at 0.05. The results were presented with frequencies and percentage, adjusted odd ratio with 95% confidence interval, Wald statistic and corresponding P value

RESULTS

The total number of patients in this study was 268. The socio demographic data of respondents is summarized in Table III. Mean age of the analyzed patients was 50.9 years ± 11.9 (SD) with majority (59.0%) being woman. The youngest patient was 21 years old and oldest was 76 years old. The peak age of ruptured aneurysm in our study was at 40 - 60 years old, comparable with most published results[8]. The race distribution in this study which shows predominantly Malay, followed by Chinese, Indian and others which may in fact reflect the diversity of local population rather than racial predominance in aneurysm rupture.

In our study, patient of age group less than 40 years have significantly good mRS outcome (74%). On the other hand only 57.3% patients above 40 had better mRS outcome at 6 months. In regard to treatment modalities in patients above 40 years of old we could not find statistical difference in outcome (Table VI).This finding is consistent with study done by Petros Nikolaos Karamanakos[9] who did not find improvement in 12-month survival in the elderly after the establishment of endovascular therapy at his institute in Eastern Finland.

Table IV shows patient who underwent coiling appeared to have a better mRS score at the end of 6 months as compared to microsurgical clipping group ($p<0.05$). However when Chi-square test was applied to analyze the association between treatment group and mRS outcome in selected good WFNS group, it was noted that there was no significant association between treatment (clipping and coiling) group. Similar result was reproduced in poor WFNS presentation.

Fisher Exact Test was applied to analyze the association between treatment group and mRS outcome in selected posterior circulation. In posterior circulation, coiling had better mRS outcome as compared to clipping. In selected poor WFNS of posterior circulation, treatment group is associated with 100% poor mRS outcome.

Repeat procedures are more likely in coiling group as compared to clipping. As seen in Table V, Fisher Exact Test shows significant statistical association between treatment group and repeat procedure ($p<0.05$).

In Table VI, patients who are less than 40 years have better outcome at 6 months. Chi –square test was applied to analyze the outcome compared to age factor which shows significant association between age and outcome ($p<0.05$). There is also a very significant association between good WFNS grade and good mRS outcome at 6 months ($p<0.01$). However requirement of EVD, CSF infection and pneumonia are likely associated with poor outcome.

DISCUSSION

Detachable coils were introduced to occlude the aneurysm over last 2 decades as an alternative treatment of surgery. In recent years it has become more common among the neurosurgical units around the world[6]. However the best approach remains controversial. Literature review reveal contradicting results in different series. In this study we were interested on how both type of treatments had an impact on functional outcome of patient at 6 months follow up in our hospital.

We reviewed records of patient of total 268, who underwent clipping and coiling in HKL for last 5 years (2005-2009). We retrospectively analyzed the data to determine the association between two treatment methods with good functional outcome of patients, morbidity and mortality at 6 months. The impact of other associated factors like clinical presentation, Fisher grade, clinical vasospasm, length of hospital stay, EVD, CSF infection, VP shunt and pneumonia were also studied.

Overall, from the assessment of this study, we found statistically, coiling has a better mRS outcome at 6 months compared to clipping ($p<0.05$). The clipping outcome group had 204 patients and only 115 patients had a better outcome (56.4%) In coiling group 73.4% out of 64 patients had a good mRS outcome. The morbidity in clipping group is also higher at 43.6 % as compared to 26.6% in coiling group. The mortality in surgical clipping is at 20.6%, while coiling at 12.5%. However, there was higher percentage of patients with poor WFNS grade at presentation in clipping group and statistical significant ($p<0.05$). This may explain the poorer outcome in clipping group.

In reference to International Subarachnoid Aneursym Trial (ISAT) study[10], the outcome in their coiling group at 2 months is almost similar with our study with their good patient

Table I: The World Federation of Neurosurgical Scale (WFNS) grade

Grade	Description
1	GCS 15, no motor deficit
2	GCS 13 to 14, no motor deficit
3	GCS 13 to 14 with motor deficit
4	GCS 7 to 12, with or without motor deficit
5	GCS 3 to 6, with or without motor deficit

Table II: The Modified Rankin scale

Score	Description
0	No symptoms
1	M No significant disability despite symptoms, able to carry out all usual duties and activities (E (Engages fully in all previous activities but may have residual symptoms)
2	Slight disability unable to carry out all previous activities but able to look after own affairs without assistance
3	Moderate disability requiring some help, but able to walk without assistance. (May use assistive device but no physical assistance).
4	Moderately severe disability: unable to walk without assistance, and unable attend to own bodily needs without assistance (Assistance includes physical assistance or verbal instruction by another person.)
5	Severe disability: bedridden, incontinent and requiring constant nursing care and attention. (Constant care: usually bedridden, moving from bed to sitting requires major assistance)
6	. Dead

Table III: Frequency of distribution demographic of patients

Variables	Frequency	%
Age (years)	50.9*	11.89**
Gender		
Male	110	41
Female	158	59
Race		
Malay	157	58.6
Chinese	87	32.5
Indian	18	6.7
Others	6	2.2
Anterior circulation aneurysms	239	89.2
Posterior circulation aneurysms	29	10.8
Good WFNS(1-2)	181	67.5
Poor WFNS (3-5)	87	32.5

*. Mean
**. Standard deviation

outcome of 73.9% and poor outcome at 26.1%. In ISAT surgical group, 63.1% have better outcome as compared to 56.4% in our study. The difference in outcome of our study can be easily explained by presence of 88% patients in good group (WFNS 1-2)[10] of ISAT study. In our study, only 67.5% patients were of good WFNS group. Inclusion of poorer grade SAH patients who received treatment resulted in poorer outcomes in this study[11].

As this is a retrospective non randomized study, we unmask the effect of initial clinical presentation by controlling the WFNS grade of presentation. In selected good WFNS group (WFNS 1-2), 76% from clipping group patients had good mRS outcome whereas in coiling group, 86.5 % of patients had a good outcome. However, this result is not statistical significant to suggest the best treatment options (p=0.12). Further, in poor WFNS presentation, the surgical group had better outcome with 22.7% good outcome and 77.3% poor outcome. In coiling group, only two patients fared well at 16.7% and had poor outcome with 83.3% patients.
In addition, our selected WFNS grade (1-2) surgical group patients showed a much better results (76% good outcome) even when compared to coiling group of ISAT study (73.9%good outcome). There are other studies that showed better outcome results when compared to ISAT. Yoshie Nakamura[12] in his gross comparison with his series and ISAT studies found that the surgical outcome in Japan is much more favorable.

The clinical presentation has a very significant impact on outcome of patients. In our study, 79% of good WFNS group obtained good mRS outcome. 21% had poor outcome. Similarly in poor WFNS group, the outcome is almost inversely proportional. Only 21.8% patient had good mRS outcome while78.2% had poor outcome. This finding is statistically very significant (Table VI).

Ruptured aneurysms were more commonly located in the anterior than posterior circulation[13]. With respect to our study population, 89.2 % of cases were in anterior circulation and much smaller number, 10.8% in posterior circulation (Table III). Out 194 patients who underwent clipping in anterior circulation, 110 patients had a good outcome (56.7%). In comparison, 31 patients from 45 endovascular patients had a good MRS outcome (68.9%). In anterior circulation, 77.8% of patients in coiling group presented with good WFNS as

Table IV:Association between treatment group and outcome

	Clipping, n(%)	Coiling, n(%)	X2stat (df)	P value
mRS				
Good(0-2)	115(56.4%)	47(73.4%)	5.934(1)	0.015[a]
Poor(3-6)	89(43.6%)	17(26.6%)		
mRS(Good WFNS)				
Good	98 (76%)	45(86.5%)	2.496(1)	0.015[a]
Poor	31 (24%)	7(13.5%)		
mRS(Poor WFNS)				
Good	17(22.7%)	2(16.7%)	-	1.00[b]
Poor	58(77.3%)	10(83.3%)		
mRS (Ant Circulation)				
Good	110(56.7%)	31 (68.9%)	2.243 (1)	0.13[a]
Poor	84 (43.3%)	14 (31.1%)		
mRS (Post. Circulation)				
Good	5(50%)	16 (84.2%)	-	0.083[b]
Poor	5(50%)	3 (15.8%)		
Mortality				
Yes	42(20.6%)	8(12.5%)	2.100(1)	0.147[a]
No	162(79.4%)	56(87.5%)		
Aneurysm type ACOM				
Good mRS	42(61.8%)	7(58.3%)	-	1.00[b]
Poor mRS	26(38.2%)	5(41.7%)		
MCA				
Good mRS	28(62.2%)	2(40%)	-	0.377[b]
Poor mRS	17(37.8%)	3(60%)		
PCOM				
Good mRS	17(43.6%)	8(72.7%)	2.914(1)	0.088a
Poor mRS	22(56.4%)	3(27.3%)		
Basilar				
Good mRS	2(50%)	10(76.9%)	-	0.538[b]
Poor mRS	2(50%)	3(23.1%)		

[a] Pearson X^2 test applied; [b] Fisher's exact test applied

compared to clipping group with 63.9%. A further analysis in outcome of coiling and clipping in good WFNS group within anterior circulation did not reveal statistical difference statistical (p=0.13).

Similarly in posterior circulation, the coiling group appears to have better outcome with 16 patients (84.2%) out of 19 to have a good mRS score. In the clipping group, only 5 (50%) out of 10 patients had good mRS score. However, despite the difference, the outcome is not statistically significant (p=0.08). A further subanalysis in posterior circulation with good WFNS shows that the 5 patients from clipping group had good outcome (100%) as compared to 16 from 21 patients (95.5%) in coiling had good outcome WFNS.

In posterior circulation of poor WFNS, the outcome is dismal. All 5 patients from clipping and 2 patients from coiling group had poor mRS outcome (100%). It appears that patients with poor grade admission with posterior circulation aneurysm do not benefit from any treatment.

In term of aneurysm type, our finding showed that clipping has better outcome in Anterior Communicating Artery aneurysm (ACOM) (61.8%) and Middle Cerebral Artery Aneurysm (MCA) (62.2%) in comparison with coiling (58.3% for ACOM and 40% for MCA). However, coiling has better outcome in Posterior Communicating Artery Aneurysm (PCOM) (72.2%) and basilar (76.9%) in comparison with clipping (43.6% for PCOM and 50% for basilar).It appears that ACOM and MCA aneurysms should be clipped and PCOM with basilar aneurysm should be coiled. However, the differences are not statistical significant (Table IV).

In our study, we found that in CT Fisher group 1 and 2, which are at the lower of risk of vasospasm, 23 patients (92%) of 25 have significantly better outcome at 6 months as compared to 139 (57.2%) out of 243 patients in Fisher group 3 and 4. This finding is statistically significant (p>0.05) to show patient with CT Fisher grade 1 and 2 have better outcome in comparison with patient with CT Fisher grade 3 and 4.

Cerebral vasospasm is seen angiographically in 70% and clinically in 20 to 30% of patients with aneurysmal subarachnoid hemorrhage as shown in the literature reviews. Despite maximal therapy, nearly 50% of patients with symptomatic vasospasm will develop stroke[14]. The low incidence of vasospasm in our study is possibly due to inadequate objective methodology of assessing the clinical

Table V: Association between other factors and treatment groups

	Clipping, n (%)	Coiling, n (%)	X2stat (df)	P value
WFNS				
Good(1-2)	129(63.2%)	52(81.3%)	7.211(1)	0.007[a]
Poor(3-5)	75(36.8%)	12(18.8%)		
Clinical vasospasm				
Yes	10 (4.91%)	6 (9.4%)	0.188 (1)	1.74[a]
No	194 (95.1%)	58 (90.6%)		
Repeat procedures				
Yes	2 (1%)	7(10.9%)	-	0.01[b]
No	202(995)	57(89%)		
Co-morbidities				
Yes	22(10.8%)	4(6.3%)	-	0.342[b]
No	182(89.2%)	60(93.8%)		
EVD				
Yes	50(24.5%)	6(9.4%)	6.751(1)	0.009[a]
No	154(75.5%)	58(90.6%)		
CSF infection				
Yes	22(10.8%)	4(6.3%)	-	0.342[b]
No	182(89.2%)	60(93.8%)		
VP Shunt				
Yes	28 (13.7%)	4(6.3%)	-	0.125[b]
No	176 (86.3%)	60(93.8%)		
Pneumonia				
Yes	50(24.5%)	6(9.4%)	6.751(1)	0.00[9a]
No	154(75.7%)	58(90.6%)		

[a] Pearson X^2 test applied
[b] Fisher's exact test applied

Table VI: Association of influencing factors and outcome

	Good MRS, n(%)	Poor MRS, n(%)	X2stat (df)	P value
Age				
<40	37 (74%)	13(26%)	4.722 (1)	0.03[a]
>40	125(57.3%)	93(42.7%)		
Fisher Grade				
1-2	23 (92%)	2(8%)	-	0.01[b]
3-4	139(57.2%)	104(42.8%)		
WFNS				
Good(1-2)	143 (79%)	38(21%)	80.315(1)	0.001[a]
Poor (3-5)	19(21.8%)	68(78.2%)		
EVD				
Yes	24(29.6%)	57(70.4%)	46.115(1)	0.001[a]
No	138(73.8%)	49(26.2%)		
CSF infection				
Yes	3 (1.9%)	23(21.7%)	-	0.001[b]
No	159(98.1%)	83(78.3%)		
VP Shunt				
Yes	15(46.9%)	17(53.1%)	2.800 (1)	0.94[a]
No	147(62.3%)	89(37.7%)		
Pneumonia				
Yes	16(28.6%)	40(71.4%)	30.087	0.001[a]
No	146(68.9%)	66(31.1%)		
Vasospasm				
Yes	4 (2.5%)	12 (11.3%)	-	0.006[b]
No	158 (97.5%)	94 (88.7%)		

[a] Pearson X^2 test applied
[b] Fisher's exact test applied

vasospasm. Unavailability of transcranial ultrasound Doppler and limited angiography service also hampers any study of radiological vasospasm.

Nevertheless, from the data that is available, we found that vasospasm occurs only in Fisher group 3 and 4 which is similar to an earlier study by Fisher[15] and this study noted significant association of poor outcome occurs with clinical vasospasm ($p<0.01$). There is no significant difference of vasospasm occurrence between the two treatment groups ($p=0.81$).

We have also found that in coiling, 10.9% cases require repeat procedures due to incomplete coiling. In comparison, only 2 patients (1%) in surgical group required repeat procedure (Table III). Hospital stay in coiling group (even among good grade patients) is significantly shorter than surgical group. This finding is similar to other previous studies[16]. It is possible that a longer duration of surgery may require longer post-operative ventilation. However, repeat treatment procedures in 10.9% patients may off-set the cost saving of shorter duration hospital stay. Furthermore, as mentioned earlier, higher number of poor WFNS was admitted in surgical group and this may contribute to longer hospital stay.

Factors influencing the outcome were studied. We found that hydrocephalus requiring Extra Ventricular Drain on presentation ($p<0.01$), CSF infection (<0.01) and pneumonia ($p<0.01$) were significantly associated with poor outcome. Absence of EVD is a significant predictor of a good mRS outcome. It is possible that patient who had EVD was exposed to a higher chance of CSF infection leading to meningitis and ventriculitis which are associated with high morbidity and mortality. Patient requiring Extra Ventricular Drain may also likely to develop pneumonia and sepsis, as they are often bed bound. Patients with pneumonia and sepsis are likely to fare less than the others.

CONCLUSION

This retrospective analysis demonstrated that regardless of treatment option, functional outcome after SAH is dependent upon clinical presentation prior intervention. In our centre, this is determined by WFNS grade. Good WFNS grade is a significant predictor for good mRS outcome. Treatment methods have no significant association with functional outcome at 6 months.

In this study, it is suggestive that surgical method is a preferred method for MCA aneurysm while endovascular coiling is preferred for PCOM and Basilar. However, the treatment option for each patient should be individualized based on the clinical presentation location and expertise available. Regardless of treatment of choice, patient with poor WFNS score in posterior circulation will have poor mRS outcome at the end of 6 months.

Patient presented with Fisher Grade 1 and 2 do have better outcome in comparison of Fisher Grade 3 and 4. Absence of EVD requirement is a significant predictor of good mRS outcome.

There is a need for standardized prospective study of specific aneurysm types and outcomes. A detailed analysis of each aneurysm, its morphology, location and treatment options should be included. An ongoing analysis can take account of improved technological development of treatment modalities.

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