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Intracranial Aneurysms: Acute VS Delayed Surgery - An Analysis of 52 Cases

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Abstract:

Background: *Aneurysm surgery is increasing day by day in our country but the exact timing of surgery is still controversial.* ***Objectives:*** *The aim of this study was to determine the results of early and late surgery for aneurismal subarachnoid haemorrhage. The aim of microneurosurgical management of an aneurysm is the total occlusion of the aneurysm sac by clipping at the neck of aneurysm with preservation of flow in the parent artery and preservation of all its perforating arteries with minimal or no brain retraction.* ***Methods:*** *There were 52 patients included in this study among them 3 patients expired soon after the admission before surgery could take place. Hence 49 patients underwent clip surgery from July 2005 to May 2012 for 52 aneurysms because 3 patients harboured multiple aneurysms. Patient's history, clinical findings, Hunt & Hess grading, Fisher grading of CT scan, preoperative & postoperative CT angiography, postoperative outcome were collected and analyzed.* ***Results:*** *Most of the clipping (57.14%) were done in intermediate stage (4th to 10th days), because patients usually referred from peripheral hospital on 2nd or 3rd day after the acute SAH Those who was admitted early and H&H status good, was fit to do early surgery (within 3rd day), (28.57%). Overall outcome was assessed at 3 months after SAH using the Glasgow Outcome Scale. Good outcome were observed in 40 cases among them 22 cases (42.3%) were able to return premorbid activities. Total mortality in this series were 10 cases (19.23%) which includes preoperative death while waiting for clipping -3 cases and postoperative death- 7 cases(14.2%).* ***Conclusion****: There is no reason to postpone clipping surgery in patients who are eligible for surgery at day 5. Surgery after day 10 is associated with worse outcome. Although these studies is having high rate of mortality which can be progressively minimize by our continuous improvement of surgical skills and postoperative critical care management of aneurysm patients.*

Key word: *aneurysm, craniotomy, clipping.*

Introduction:

Aneurysms resemble bubbles or focal dilation of arteries that occur at weak points of the artery wall (figure-1). There are many factors for its formation. These factors include genetic predisposition, the anatomy of the artery and its branches, 'wear-and-tear' on the wall of the arteries due to blood flow, artery disease and cigarette smoking[1]. Aneurysms are the most common at circle of Willis in the central skull base. Approximately 80% of aneurysms arises from anterior circulation of the brain, while 20% form posterior circulation of the brain[1.2].

It is uncommon to diagnose an aneurysm before it has ruptured and most people with aneurysms are unaware that they have an aneurysm until it bursts. Overall 3.6-6% of normal population has aneurysm, among them 1.4-1.9 % rupture in a year. Women have more tendencies to rupture. There is seasonal variation of rupture[3].

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It is known that the majority of aneurysms that have ruptured are less than 10 mm in size[3.4]. Over the next 5 years after diagnosis an average aneurysm between 2 and 6 mm in size has a risk of bleeding between 1 and 2%, an aneurysm between 7 and 9 mm size has a five year risk of bleeding of 6%, an aneurysm between 10 and 24 mm in size has a five year risk of bleeding of 11% and larger aneurysms have a 28% chance of bleeding[3.4].

The history of intracranial aneurysm surgery is not a long one. The first direct operation on an intracranial aneurysm was performed by Norman Dott, who wrapped a ruptured aneurysm in 1933, and the first clipping of an aneurysm was performed by Walter Dandy in 1938[5.6]. The results of surgery improved dramatically when the operating microscope was introduced in the 1960s and a subsequent improvement followed the use of the calcium antagonist nimodipine and the maintenance of a high fluid intake to lessen the risk of delayed cerebral ischemia[7]. For many years clipping for the aneurysm was regarded as the definitive mode of treatment, but the development of the GDC coil in 1990 allowed an alternative approach that avoided the hazards of open surgery[7].

After an aneurismal subarachnoid haemorrhage, there are two major sources of morbidity and mortality: rebleeding and delayed ischemia secondary to cerebral vasospasm. The incidence of rebleeding is greatest immediately after the initial haemorrhage, and the incidence of vasospasm is highest between the 5th and 9th days after the ictus[8]. It thus seems logical to proceed with early surgery, such an approach is certainly the best means for eliminating rebleeding as a source of morbidity and mortality. Early surgery also facilitates the management of cerebral vasospasm by volume expansion and induced hypertension manoeuvres that are quite risky in the patient with an untreated aneurysm[8].

The anterior communicating artery (AcomA) is a recognized site of aneurysm predilection accounting for more than one fourth of all cerebral aneurysms in several large studies[9]. Because of

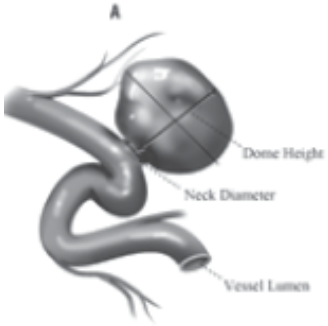


Fig.-1: *Showing various dimensions of an aneurysm*

the complexity and diversity of the geometry and flow conditions in the AcomA, it is not surprising that aneurysms of the AcomA are considered the most complex of the anterior circulation. It is widely believed that the initiation, growth, and, ultimately rupture of cerebral aneurysms are related to the interaction between hemodynamic forces with the arterial wall biology, resulting in a localized weakening of the wall. Aneurysms of the AcomA complex are more likely to have asymmetric A1 segments and furthermore, to have exclusive filling angiographically from A1 segment in up to 78% cases.[9]

Posterior communicating artery (PCOM) aneurysms are another most common aneurysms encountered by neurosurgeons and neuro-interventional radiologists and are the second most common aneurysms overall (25% of all aneurysms) representing 50% of all internal carotid artery (ICA) aneurysms[10]. Not only these aneurysms can present with a typical subarachnoid haemorrhage, but also they can present with an isolated oculomotor nerve palsy (OMNP) or a non-traumatic subdural hematoma (SDH).

Jane *et al*, evaluated the risk of rehaemorrhage in ruptured ACOM and PCOM aneurysm, finding a 50% risk of rerupture within the initial six months followed by 3.5% per year thereafter[11].

The surgical treatment of basilar tip aneurysms remains one of the most difficult tasks in neurosurgery because the view is obscured due to the depth of the aneurysm, overlapping neurovascular and bony structures, and the proximity of perforators[12].

Despite the many studies about timing for surgery in subarachnoid haemorrhage (SAH), the optimum time is still in debate. The aim of this study was to determine the results of early and late surgery for aneurysmal subarachnoid haemorrhage. The proponents of early surgery focused on reduction of the devastating effects of aneurysmal re-bleeding within the first 2 weeks and its high mortality. On the other hand, some authors believe that delayed surgery may be better choice, because operating on the acutely injured brain may be associated with high risk for surgical morbidity and mortality[13].

Some studies advocates surgery neither early nor late, and indicate that the intermediate period in 4 to 10 days after the SAH is a risky time for surgery, because during this period the risk for cerebral vasospasm and ischemia may be very high[14].

Unlike the authors, it is our belief that early aneurysm surgery is a technically more challenging procedure than delayed surgery. Despite the use of osmotic agents, hyperventilation, and cerebrospinal fluid drainage, it is our opinion that the brain is more friable and difficult to retract safely.

However, Shabepour *et al.* study in Iran had some results different from most previous studies; they evaluated 110 aneurysmal SAH and reported that the complications of late surgeries were significantly lower than early surgeries; the complication rate in surgeries performed during first 3 days after SAH was 66.7%. This rate was 54.57% for surgeries in 3 to 14 days after SAH, and 22.9% for surgeries after 14th days[15].

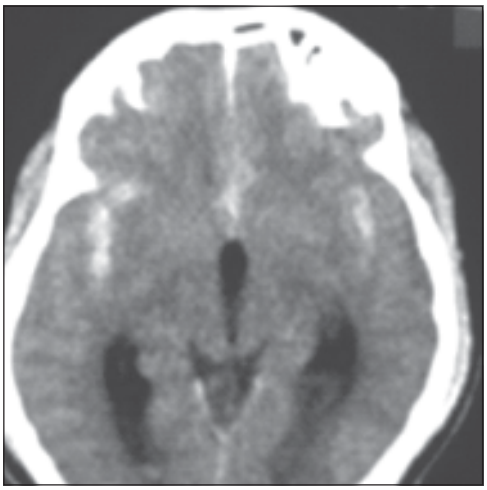


Fig.-2: *CT scan shows of SAH, Fisher grade 2.*

The aim of microneurosurgical management of an aneurysm is the total occlusion of the aneurysm sac by clipping at the neck of aneurysm with preservation of flow in the parent artery and preservation of all its perforating arteries with minimal or no brain retraction.

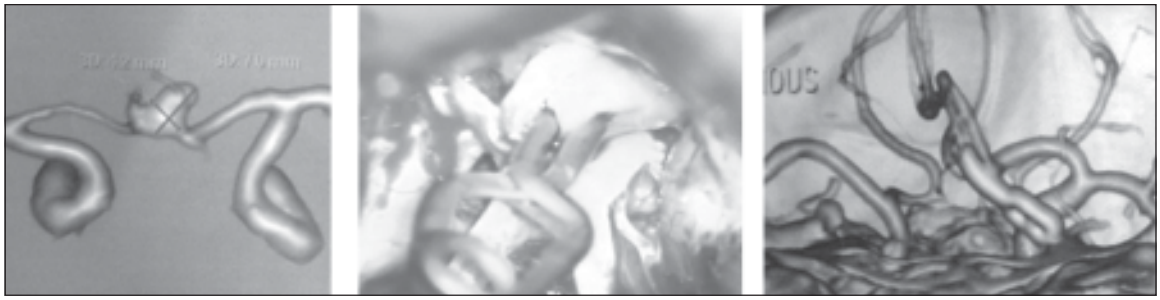
Methods:

There were 52 patients included in this study among them 3 patients expired soon after the admission before surgery could take place. Hence 49 patients underwent clip surgery from July 2005 to May 2012 for 52 aneurysms because 3 patients harbored multiple aneurysms. Patients' history, clinical findings, Hunt & Hess grading, Fisher grading of CT scan (figure-2), preoperative & postoperative CT angiography, postoperative outcome were collected and analyzed.

About 90% of aneurysms were accessible via a standard frontotemporal (pterional) craniotomy centered over the pterion. Only occasional cases, aneurysms of the distal anterior cerebral artery and the lower vertebrobasilar trunk, require different surgical approaches. The risk of intraoperative rupture of the aneurysm, which occurs in 5-10% of cases, can be minimized by induction of hypotension. This seems a safe measure provided that the anaesthetist ensures maintenance of a high blood volume. We preferred not to apply temporary clips to the main artery proximal to the aneurysm because it was associated with a high incidence of ischemic cerebral damage. Temporary clipping was certainly not tolerated if the blood pressure is lowered at the same time.

Surgical steps

Acom aneurysm: Pterional craniotomy is commonly done for this. We prefer to approach from right side however sometimes it needed to approach from left side when. Left A1 is dominant and Ipsilateral and contralateral A2 is well visualized from left side. We prefer 5-10 degree rotation to the contralateral side to keep the figure of H in vertical position. Wide sylvian fissure dissection was done for gentle retraction of frontal lobe. Anterior interhemispheric fissure was dissected to avoid gyrus rectus resection (figure-3A,3B,3C).



A B C

Figure-3: *CT angiogram shows ACOM aneurysm (A), Peroperative clipping of ACOM aneurysm (B) & Post clip angiogram shows no residual aneurysm (C).*

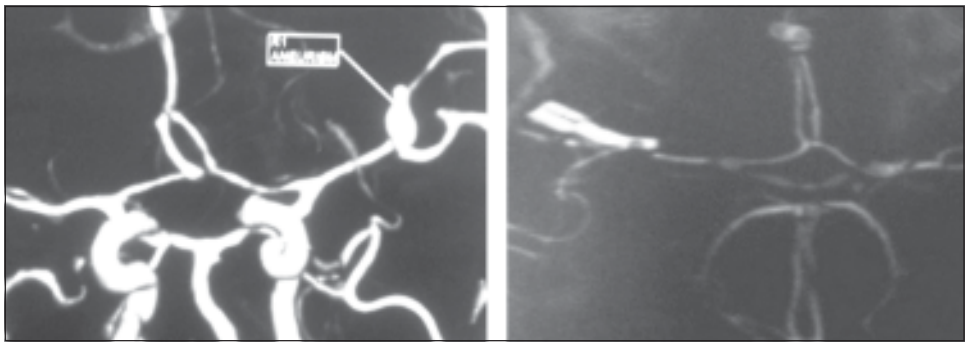
Pcom aneurysm: Pterional craniotomy with rotation 60-75 degree to contralateral side for posteriorly directing aneurysm which allows the aneurysm to be seen in profile with carotid artery. The oculomotor nerve should be identified and protected. It is not necessary to expose the aneurysm dome. When the inferior and superior aspect of aneurysm has been identified and adjacent arteries made free, then the aneurysm can be safely clipped.

MCA aneurysm: Pterional approach with turning the patient head 45 degrees to contralateral side - means the operative pathway will be almost vertically downward along the sphenoid ridge. This reduces the need for retraction of temporal lobe , and often only needs the frontal lobe to be retracted. The head is also extended to allow the frontal lobe to fall. Finally the rotated, extended head is elevated upward to facilitate venous return.

Basilar top aneurysm:

Pterional craniotomy with head is positioned in a Mayfield head holder with the head elevated above the shoulder level and 20 dergree rotation to the contralateral side away from the operative side. The head is extended until the maxillary eminence is highest point in the field. A pterional craniotomy is then performed followed by drilling of sphenoid ridge and orbital roof until a flat surface is achieved so that straight trajectory to the proximal carotid can be visualized along the skull base.

For preexisting hydrocephalus or in case of brain swelling during surgery we are in need of brain relaxation. This can be done by a ventricular catheter placed in “paine’s point”. This is done by aiming perpendicularly to the triangle 2.5 cm back along the sylvian fissure and 2.5 cm superiorly.



A B

Figure 4: *CT angiogram shows left MCA aneurysm (A) & Post-clip angiogram shows no residual aneurysm (B).*

Results:

The mean age group of our study was 45.7 years. Age varies from 16- 70 years. Male: female ratio was 1:08. In our study male are commoner then female.

Hunt and Hess grades at admission are summarized in Table I. Thirty seven patients (71.2%) were classified as Grade I-II, Twelve patients (23.0%) as Grade III-IV. 3 patients (5.7%) as Grade V.

Table-I

Distribution of Hunt & Hess Grading: (n=52)

Hunt & Hess Grading	No. of cases
I – II	37 (71.215%)
III-IV	12 (23.07%)
V	3 (5.76%)

The subarachnoid clot thickness -Fisher grading at admission were summarized in Table-II. 84.4% of cases were in grade I-II. 4 cases(7.6%) were in grade III-IV. Only 4 cases (7.6%) were grade V.

Table-II

Distribution of Fisher grade of Aneurysms: (n=52)

Fisher Grading	No. of cases
I – II	44 (84.61%)
III-IV	4 (7.69%)
V	4 (7.69%)

Cerebral CT angiography was performed at admission in all patients (angiography was performed within 48 hours of haemorrhage onset in most of the cases). The location and size of the ruptured aneurysm were obtained from a review of angiographic images. Commonest aneurysm found in ACOM location which was 42.30%. Next commoner the PCOM which constitute 26.92% and MCA aneurysms were 9.61% . Basilar top aneurysms were found only in 4 cases (7.6%) (Table-III). The aneurysm was single in 92.9% and multiple aneurysms were found in 3 cases (5.76%).

Table-III

Distribution of CT angiographic findings of Location of Aneurysms:(n=52).

Location of Aneurysms	No. of aneurysms
ACOM aneurysm	22 (42.30%)
PCOM aneurysm	14 (26.92%)
MCA aneurysm	5 (9.61%)
ICA aneurysm	5 (9.61%)
DACA aneurysm	2 (3.84%)
Basilar top aneurysm	4 (7.69%)
Paraclinoid aneurysm	2(1.92%)
Vertibrobasilar junctional aneurysm	1(1.92%)
Total	52 (100%)

Aneurysm size was categorized in three groups. Small sizes were between 4-10 mm - constitute the commonest size which were 84.6%. Large sizes were between 11-25 mm constitute 11.5% and >25 mm were giant aneurysm which was only2 cases(Table IV).

Table-IV

Distribution of Size of Aneurysms, (n=52)

Size of Aneurysms	No. of Aneurysms
4mm – 10mm	44 (84.61%)
11mm – 25mm	6 (11.53%)
<25mm	2 (3.84%)
Total	52

Pterional craniotomy (91.8%) was the most common approach for most of the aneurysm both for almost all anterior and some posterior circulation aneurysm. Contralateral pterional approach were done in 3 cases(6.12%). For vertebrobasilar junction retrosigmoid suboccipital craniectomy was choiced. For DACA aneurysm anterior interhemispheric approach was chosed.(Table-V).

Table-V

Distribution of Name of Surgery (n=49)

Name of Surgery	No. of cases
Pterional Crainotomy	45 (91.83%)
Orbitopterional Crainotomy	1 (2.04%)
Contralateral Pterional Crainotomy	3 (6.12%)
Retrosigmoid suboccipital approach	1(2.04%)
Total	49 (100%)

Most of the surgery(57.14%) were done in intermediate stage(4^{th} to 10^{th} days), because

patients usually referred from peripheral hospital on 2nd or 3rd days after the acute SAH. Those who was admitted early and H&H status good , was fit to do early surgery (within 3rd day) (28.57%). Those who were poor H&H grade at admission and or CT angiogram reveled sign of vasospasm and those having medical co-morbidity such as asthma, coronary ischemia, were not able to do early or intermediate surgery hence they were selected for late surgery(after 11th day onward)(table-VI). Two patients who died from rebleeding while waiting for surgery although they were fit for surgery at anytime. Another one patients died from severe vasospasm so soon after admission that surgery could not have been performed.

Table-VI

Distribution of Day of Aneurysm Surgery (n=49)

Day of Aneurysm Surgery	No. of aneurysms
1st day – 3rd day	14 (28.57%)
4th – 10th day	28 (57.14%)
>11th day	7 (14.28%)
Total	49 (100%)

Overall outcome was assessed at 3 months after SAH using the Glasgow Outcome Scale. Good outcome were observed in 40 cases among them 22 cases (42.3%) were able to return premorbid activities. Poor outcome was defined by the Glasgow Outcome Scale criteria of death, vegetative state, or severe disability. Total mortality in this series were 10 cases (19.23%) which includes preoperative death while waiting for clipping -3 cases and postoperative death -7 cases(14.2%) (Table -VII).

Table-VII

Distribution of Glasgow outcome scale (N=52)

Good outcome	No. of cases
1. Return to premorbid occupation	22(42.30%)
2. Neurologically normal, not returned to premorbid occupation	10(19.23%)
3. Independent, mild neurological deficit	5(9.61%)
Poor outcome	
4. Dependent, significant deficit	5(9.61%)
5. Dead(preop-3cases + postop-7cases	(14.2%) 10(19.23%)
Total	52 (100%)

Commonest complication of aneurysm sugery were rerupture during dissection of aneurysm sac which occurred 7.6% cases. Incompletely clipped aneurysm also reruptured in postoperative period which occurred 3.8% cases. Postoperative severe hypotension developed in 5.7% cases. Most common causes of postoperative mortality in our series were from hypotension and improper management of vasospasm. Rerupture from incompletely clipped aneurysm were accounted 2 cases which lead to death(table-8). Postoperative vasospasm & limb weakness were another common problem for which we need to manage by ionotrophic agent like dopamine, adrenaline & dobutamine. Subdural hematoma , meningitis , and acute and late hydrocephalus were some minor complications (Table- VIII).

Table-VIII

Distribution of Complications of Aneurysm (n=52)

Complication	No. of cases
Re-rupture while waiting	2 (3.84%)
Preop severe vasospasm	1(1.92%)
Intraoperative rupture	4 (7.69%)
Post operative rupture	2 (3.84%)
Post operative hypotension	3 (5.76%)
Pre operative vasospasm	6 (11.53%)
Newly developed Post operative vasospasm & hemiplegia	5 (9.61%)
Post operative subdural haematoma	2 (3.84%)
Meningitis	5 (9.61%)
Hydrocepalus	3 (5.76%)
Tension pneumocephalus	1(1.92%)
VP shunt	3 (5.76%)
No complications	15(28.84%)
Total	52(100%)

Discussion:

Pterional craniotomy was the most common approach for both anterior and posterior circulation aneurysm[16]. However some author choose orbitopterional craniotomy in case of ACOM aneurysm in acute setting. In one study overall outcomes at discharge using the Glasgow outcome scale of those who underwent pterional craniotomy were good in 52 (69.4%) patients, fair in 13

(17.3%), and poor in 10 (13.3%) among 75 cases of ACOM aneurysm. At last follow-up after 6 months of surgery, outcomes were good in 63 (84%) patients, fair in 6 (8%), and poor in 6 (8%). Disability included mild in 10%, partial in 18.8%, moderate in 8.6%, moderately severe in 1.4%, severe in 2.9%, extremely severe in 2.9%, and vegetative state in 1.4%. Overall 74% of patients returned to work after 4 months, 83% of previously unemployed patients returned to baseline, and 25% were disabled[17]. In this study good outcome were observed in 40 cases among them 22 cases (42.3%) were able to return premorbid activities. Poor outcome were observed in 15 cases among them 7 cases were died following surgery(14.2%) Here our postoperative mortality was quite high (14.2%), this was probably from interaction of many factors –such as patient factor-delay admission, hesitation regarding giving consent for operation in good H&H status, postoperative poor nursing management , and surgeons skill.

Samson *et al.* reported that the outcome and complications of early surgery on first 8 days after SAH were not different from late surgery in 9 to 31days after SAH, but ischemic events after early surgery were significantly higher[18].

Temporary clipping and projection of the aneurysm did not affect the outcome. Causative factors of unfavorable outcomes were primary brain damage by haemorrhage in cases of small and large aneurysms and perforator damage in the case of giant aneurysm. Poor clinical H&H grade and vasospasm are the causative factors of poor outcome in patients with ruptured aneurysm. The poor outcome could also have been correlated with poor clinical condition at admission, early rebleeding , or early deterioration from other causes[19].

Once the neck of the aneurysm was adequately exposed, then we must pay significant attention to preservation of the parent artery, perforators without significant manipulation of the fundus[19]. Leipzig *et al*, reviewed a large series of aneurysm clipping looking for risk factors of intraoperative rupture. PCOM aneurysms had the second highest rate of intra-operative rupture (second only to ACOM aneurysms) amongst anterior circulation aneurysms[20] .

A strong correlation was found between rehaemorrhage and residual aneurysm. Risk of rehaemorrhage increased from 1.1% in completely occluded aneurysm to 17.6% in a partially treated aneurysm where residual filling of the dome was left untreated. Also the median time to rerupture was only three days[19]. In our series 2 cases developed reruptured in early postoperative period among 49 cases of operatively treated aneurysm (table-VIII)

Aneurysm surgery are increasing day by day, probably because of improvement of motivation of the patient party, availability of investigation and availability of aneurysm clip of various size and shape in our country.(Diagram-1)

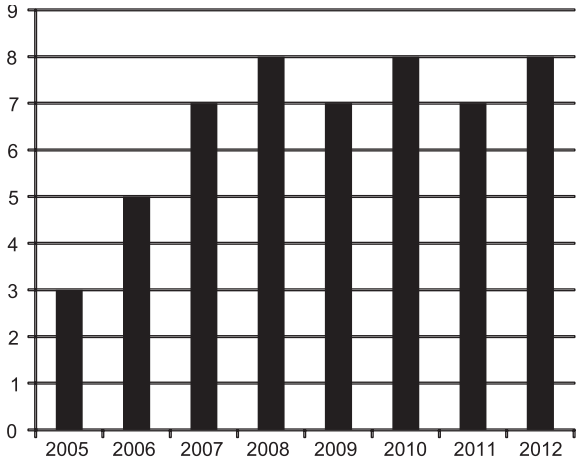


Diagram-I *Bar diagram of aneurysm cases in year. (n=52).*

There are 3 possible explanations for the observed better outcomes among SAH patients treated within 72 hours of admission: (1) the death and disability associated with rebleeding is reduced; (2) the death and disability related to cerebral vasospasm is reduced because more intensive measures can be undertaken with secured aneurysms; and (3) early treatment is a marker of higher performance on several quality care parameters [20].

The international cooperative study on the timing of aneurysm surgery recruited 3521 patients with aneurusmal SAH. There was no difference in good

outcome defined by Glasgow outcome scale at 6 months in early (0-3day) and delayed (11-14 day) surgery group but lower rate were observed in intermediate (7-10 day) surgery group. The rate of rebleeding in early surgery group 5.7% in compared with 13.9% delayed surgery group[21]. A subgroup analysis on north American population(772 patients) demonstrates high rate of good outcome in early vs delayed group (70.9%-61.7%) respectively even though there is no mortality. A recent data reevaluate the definition of early treatment (0-2 days vs 0-3 days) proposed by international cooperative study trail. A major benefit of early surgery lies in the decreasing frequency of rebleeds that occurs in the interim period before aneurysm treatment is performed[22].

In our study the hospital stay in early surgery group was significantly lower than late group. This finding is concordant with Ross *et al.* [23] and Bolander *et al.* studies[24].

Conclusion:

In conclusion, this study revealed that most of the aneurysm surgery were done between 4th to 10th days of post acute SAH, which reflects that timing of surgery should be individualized for each patient based on clinical situation such as age, H&H Grading, Fisher Grading, size and site of aneurysm, presence or absence of vasospasm and other medical comorbid factors. There is no reason to postpone clipping surgery in patients who are eligible for surgery at day 5. Surgery after day 10 is associated with worse outcome. Although this study is having high rate of mortality which can be progressively minimize by our continuous improvement of surgical skills and postoperative critical care management of aneurysm patients.

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