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PROJECT REPORT

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Programme :M.Ch. NEUROSURGERY

Month and year of submission :NOVEMBER -2002

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Title of the project:

SURGICAL OUTCOME OF MULTIPLE INTRACRANIAL ANEURYSMS

Name	:DR.SANJEEV KUMAR
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CERTIFICATE

I, **Dr. SANJEEV KUMAR** hereby declare that I have actually performed all the procedures listed/carried out in the project under report.

Place: Thiruvananthapuram
Date: 1st November 2002.

Signature
(SANJEEV KUMAR)
Name in capital letters

Forwarded. He has carried out the minimum requirement of procedures / etc.

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CONTENTS

INTRODUCTION:

Multiple intracranial aneurysms occur in about 30 % of all patients with aneurysm, presenting with subarachnoid hemorrhage. The exact mechanism of intracranial aneurysm formation per se remains obscured, however, congenital or/ and acquired degenerative changes in the arterial wall has been implicated. The angiography study can predict the site of rupture in majority of cases based on features , such as spasm , mass effect , aneurysm size and shape. Early reports dealing with multiple aneurysm recommended treatment of only the ruptured aneurysm, but now it is advised to treat all significant aneurysm .

It is still important to determine which aneurysm has bled so that the symptomatic lesion may be dealt first .The presence of multiple intracranial aneurysm is some time associated with poor outcome because of complex management issues that are involved and the higher complication rate from hemorrhage and any treatment .

The identification of modifiable risk factors for formation of multiple aneurysms is important and has a implication both for prevention of subarachnoid hemorrhage and more detailed understanding of the pathogenesis of multiple cerebral aneurysm .

Cerebrovascular disease risk factors such as hypertension, cigarette smoking and alcohol consumption have been shown to increase the risk of subarachnoid hemorrhage and spontaneous intracerebral hematoma, however , the role of these risk factors in formation of multiple , as apposed to single, aneurysm is less well understood.

AIMS AND OBJECTIVES:

The aim and objective of this study was to access

1.Incidence of multiple intracranial aneurysms.

2.Management protocol in multiple intracranial aneurysms.

3.Surgical outcome of multiple intracranial aneurysms.

4.Prognostic factors..

MATERIAL AND METHODS :

We have performed a retrospective review of medical records of all patients with multiple intracranial aneurysms operated in our institute from January 1991 to June 2001;

Data collection included the following.

1.Patients' age and sex.
2.Clinical presentation
3 History of hypertension or diabetes mellitus.
4.GCS at the time of admission.
5.Fisher's grading
6.Surgery after how many days of admission
7.Single craniotomy / two craniotomy in single sitting
8. Second operation as stage procedure .
9.Post operative outcome.

All patients underwent four vessel DSA, to determine cause of subarachnoid hemorrhage.

Data recorded from angiogram – number of aneurysms , location and size of intracranial aneurysms. During the 10 and a half years period from January 1991 to June 2001,1083 patients underwent surgery for intracranial aneurysms Out of which 120 patients (11%) had multiple intracranial aneurysms. There were 71 males and 49 females and age group ranged from 18 yrs to 76 years (mean age 47 years). Peak incidence seen in 5 & 6 decade. There were 285 aneurysms in 120 patients. Eighty-seven patients had 2 aneurysms, twenty-three patients had 3 aneurysms, eight patients had 4 aneurysms and two patients had 5 aneurysms, .the percentage of patients with 3 or more aneurysms was 27.5 %.

REVIEW OF LITERATURE

The word aneurysm is derived from Greek word *'aneurys'* means "dilatation" and probably from the Sanskrit word *'uru'* meaning "wide". Intracranial aneurysms and subarachnoid hemorrhage have been recognized for centuries. Biumi of Milan, in 1765, gave clear description of unruptured cavernous carotid aneurysm at post mortem in 53 yrs old lady. First account of ruptured intracranial aneurysm was by Blackhall in 1830. Brinton in 1850 collected 52 cases from literature and systemically analyzed the symptoms due to rupture of intracranial aneurysm. In 1859,Gull stressed the importance of headache as a symptom. In 1923, Symonds first described the clinical picture of subarachnoid hemorrhage in detail. He divided the signs into three groups:

- Signs of leakage of blood from the sac
- Those of disease causing the aneurysm
- Those due to local compression by the aneurysm.

Collier in 1931 first used the term *"berry aneurysm"*. Dandy did the first successful clipping of aneurysm in 1937. The dawn of modern aneurysm surgery came in 1939, when Egaz Moniz first demonstrated aneurysm by the technique of cerebral angiography. With the technical advances and general progress in radiology, anesthesia and intensive care, the mortality and morbidity came down significantly. Prominent among the workers were "Yasargil"and "Drake". In 1956,

Botterell, Lougheed and others introduced Neurological-grading system for subarachnoid hemorrhage.

Pakarinen in 1967 published the natural history of aneurysms after reviewing six series. The incidence of cerebral aneurysms in general population is about 1% while the autopsy series revealed an incidence of 2 to 6%. Nakagawa and Hashi et al found 6.5% incidence of asymptomatic cerebral aneurysms. The group with a family history of SAH had an incidence of 18%.

There are many theories proposed for the formation of cerebral aneurysms including congenital, acquired over congenital and acquired, apart from the genetic and familial factors. Now it is widely accepted that it is mainly acquired and that the internal elastic lamina is the most important layer of the vessel wall maintaining the integrity. The cerebral vessels are predisposed to aneurysm formation because of thin wall and lack of abundant elastic tissue including absence of external elastic lamina. Factors that alter blood flow, such as vessel occlusion and those that cause increased blood flow such as in AVM's, and hypertension and the factors, which the affect connective tissue, such as smoking and connective tissue disorders, may accelerate the degenerative process.

Crompton examined 149 cases at autopsy and found medial defects, internal cushions and even changes in the internal elastic lamina in cerebral arterial junction at birth, although he noted that all these lesions increased in size and number with increasing age. Arterial hypertension and renal polycystic disease were associated with increased number of large medial defects. The present

consensus is that atherosclerosis does not lead directly to the aneurysm formation. Funnel shaped dilatation; areas of thinning and small evagination were thought to be essential preaneurysmal lesions, as they were associated with severe degenerative changes in the internal elastic lamina.

The role of abnormalities of type - 3 collagen in the etiology of sacular aneurysms remain unclear. Ostergarrd and Onlund found deficiency in type - 3 collagen in middle cerebral arteries of patients who died of subarachnoid hemorrhage.

Morphologically aneurysm can be sacular, fusiform and dissecting. They are divided according to size by Yasargil into baby (<2mm), small (3-6), medium (7-14), large (15-25) and giant (>25), according to the location, anterior and posterior circulation aneurysms. The relative frequencies of aneurysm at different anatomic site vary in various series. The commonest site is anterior circulation. Use of routine 4-vessel angiography has increased detection of posterior circulation aneurysm from 5% to more than 8%. Ninty five aneurysms occur close to the circle of Willis, in relation to anterior and posterior communicating arteries and the bifurcation of internal carotid artery, middle cerebral and basilar arteries. Ruptured aneurysm tends to be larger than unruptured aneurysm and symptomatic aneurysms are larger than asymptomatic aneurysms. Size at which aneurysm usually begin to rupture is about 3 mm in maximum diameter and the size at which they begin to produce symptom by means other than rupture is around 7 mm.

MULTIPLE ANEURYSMS

INCIDENCE:

The true incidence of multiple aneurysms is not known. The numbers reported in literature vary depending on nature of the study, when the study was performed, and how the patients were selected. Incidences between 6 and 44% have been described[1], with most authors reporting an incidence between 20-30%. [2] The incidence of multiple aneurysms is generally higher in autopsy studies than in clinical studies.[3,4] In clinical studies, the incidence of multiple aneurysms has ranged from 6-44%. Generally old angiographic studies reported fewer multiple aneurysms possibly because of incomplete or technically less sophisticated angiographic technique. With newer angiographic techniques (Wilson and coworker) have reported 49%of incidence of multiple aneurysm.[1]

Multiple aneurysms are more common in women. Nehls et al,[5] noted a female-male ratio of 5:1in patients with two aneurysms, and 11:1 ratio in patients with three or more aneurysm. Others have also reported that multiple aneurysms are two or three times more common in women. It is not known that why the incidence is higher in women, but theories include the influence of hormone and higher prevalence of collagen vascular disease in women .[6,7] Age alone does not correlate with increased risk of multiple aneurysms above that for single aneurysm. Although several studies have shown an increased rate of multiple aneurysms in patients of 45 to 65 years age old. In a study of 435 patients, Inagawa[8] found a similar ratio of multiple and single aneurysm in patients over 50 years of age

CONDITIONS ASSOCIATED WITH MULTIPLE ANEURYSM

1. *HYPERTENSION*:

An association between hypertension and multiple aneurysms is noted by several authors.[6,9] Andrews and Spiegel [6] reported that in patients less than 55 years of age, multiple aneurysms were twice as common in hypertensive patients. They attributed this incidence to accelerated atherosclerosis. Housepian and Pool [10] also found arteriosclerosis to be more common in patients with multiple aneurysms than in patients with single aneurysm.

2. *ARTERIOVENOUS MALFORMATION*:

The association of arteriovenous malformations and intracranial aneurysms has been well documented. There are many reports of arteriovenous malformations associated with multiple aneurysms.[11,12] Walsh and King in 1942 reported the first example of a patient harboring an aneurysm and an AVM.[13] Batjer and associates[11] found that 11 of 22 patients with arteriovenous malformations and aneurysm had multiple aneurysms. In these patients 82% of the aneurysms were located on a vessel feeding the AVM. In all of their cases of aneurysmal SAH, the responsible aneurysms were located in an atypical distal site on a feeding vessel. A number of reports have dealt with multiple aneurysm of posterior inferior cerebellar artery (PICA) associated with cerebellar AVM.[12] Multiple PICA aneurysms do not occur at usual location of the vessel origin, but instead occur distally on the vessels feeding the AVM. Several published reports have suggested that between 2.7% & 9.3% of patients with AVM have associated aneurysm

3. *FAMILIAL ANEURYSMS*:

Familial intracranial aneurysms are defined as "*the presence of two or more family members among first and second degree relative with proven aneurysmal subarachnoid hemorrhage or incidental aneurysm*".[14] There is high incidence of multiple aneurysms in patients with familial aneurysms. Norrgard et al[15] reported a multiple aneurysm incidence of 53% in familial cases, compared with 21% in non-familial cases, this rate concerns with an incidence of about 50%, reported in other studies of familial aneurysms.[5,7,14,16] In addition patients tend to be younger by approximately 10 years and have different distribution of aneurysms. There is lower incidence of anterior and posterior communicating artery aneurysms and higher incidence of middle cerebral artery aneurysms. According to Andrews et al[5] the incidence of anterior communicating artery aneurysms is lower than that of the middle cerebral aneurysms. The incidence of anterior communicating artery aneurysms in familial cases was 16.4% and in siblings was 13.6 %, compared with a 33.5 % incidence of anterior communicating artery aneurysms in general population. The incidence of middle cerebral artery was 32% in sibling, 25.5% in familial cases and 19.8% in the general population. Female patients with a cerebral aneurysms outnumbered male patients by ratio of 3:1 (76.6%).[17] Other reports also have identified a similarly higher incidence of familial aneurysms. Andrews also indicated that in siblings, the occurrence of intracranial aneurysms at identical sites and that mirror aneurysms are more than twice as frequent as expected in general population. The mean age of the patients with

familial aneurysms is 39 years as compared to 52 years for those with nonfamilial ones.

4. ***CONNECTIVE TISSUE AND CONGENITAL DISORDERS***:

There are many connective tissue and congenital disorders associated with intracranial aneurysms. Multiple aneurysms have been associated with these disorders.[5,18]

- Ehler-Danlos syndrome
- Marfan's syndrome
- Fibromuscular dysplasia
- Coarctation of aorta
- Adult polycystic kidney disease
- Moya-Moya disease
- Tuberous sclerosis

In fibromuscular dysplasia, polycystic kidney disease and tuberous sclerosis, renal hypertension is also thought to contribute by creating haemodynamic stress that accelerates damage to the arteries. Pope et al [19] demonstrated that patients having intracranial aneurysms had a type -3 collagen vascular deficiency. The Ehlers Danlos syndrome is characterized by fragmentation or absence of elastic tissue in small arteries and also by defects of type -3 collagen. Intracranial aneurysms associated with Moya Moya disease are relatively rare and are common in the posterior circulation, 23 cases has been mentioned in literature (Yoshidide).[20] Bennet and coworkers[21] described an association of intracranial aneurysms and tuberous sclerosis. Total of 5 cases are available in review of

literature. The cause of aneurysmal formation in fibro muscular dysplasia and polycystic kidney disease (adult type) is a defect in tunica muscularis of the arterial wall. Both fibromuscular dysplasia and polycystic kidney diseases are transmitted as an autosomal dominant trait, as may be in tuberous sclerosis

5. ***SICKLE CELL DISEASE:***

Recently, an association between sickle cell disease and multiple aneurysms has been reported with an incidence of 42%. Mechanism of aneurysm formation in this disorder is thought to be due to endothelial damage from rigid red blood cells. These patients tend to be younger and have a higher frequency of posterior circulation aneurysms. .[22]

6. ***SMOKING:***

Smoking has been demonstrated to be risk factor for subarachnoid hemorrhage. The effect of smoking on intracranial aneurysm formation is not well understood.

- One hypothesis is that smoking promotes degradation of elastin in blood vessel wall, making the wall susceptible to dilation. Patients with increased elastin degradation, such as deficiency of Alfa -1-antitrypsin, may be at higher risk for aneurysm formation. Cigarette smoking has been shown to reduce the activity of alfa-1-antitrypsin .[7]
- Another hypothesis is that aneurysm formation represents degenerative processes similar to atherosclerosis. Smoking has multiple effects on endothelial cells promoting atherosclerotic changes in vessel wall. The intracranial aneurysm was significantly higher in active and previous smokers, compared to non-smoker.[23,24]

IDENTIFYING THE SITE OF ANEURYSMAL RUPTURE:

Aneurysmal distribution:

Multiple aneurysms occur at the usual sites of single aneurysms. The most common site for multiple aneurysms is along the internal carotid artery and middle cerebral artery bifurcation. Bilateral aneurysms are common in patients with multiple aneurysms. Mirror aneurysms are reported in up to 40% of cases and are especially common at the MCA (Andrews).[25]

The distribution in various series

Inagawa: .[26] ICA - 44%, MCA - 28%, ACOM - 17% and VBA - 6%

Bjorkesten and Halonen:[27] MCA - 34%, ICA&PCA - 24% each and VBA - 10%

Heiskanen:[28] ICA - 20%, MCA - 21% and ACOM - 19%.

Wilson:[1] MCA - 24%, PCOM - 23%, ICA - 21%, ACOM - 19%, VBA - 10% and ACA - 4%.

Suzuki:[29] Two aneurysm - 77%, three aneurysms - 15%, and four or more aneurysm - 6%.

47%of multiple aneurysms were on opposite site. 21% are on same side. 29% are in midline and one on the side. 3% have both in midline. When two internal carotid aneurysms coexist, the chance of having mirror aneurysm is three times greater than that of their both being on same side. When two middle cerebral artery aneurysms coexist the chance is four times greater. When anterior

circulation aneurysm is found the chance of a second aneurysm existing in posterior circulation is between 3 - 5%.

T.Inagawa:[26]	2 aneurysms	72%.
	3 aneurysms	20%
	4 aneurysms	6%
	5 aneurysms	1.5%
	6 aneurysms	0.5%
Yaz and Kobayashi:[30]	2 aneurysms	81%
	3 aneurysms	15.8%
	4 aneurysms	3.2%

PROBABILITY OF RUPTURE BY ANEURYSM SITE:

INCIDENCE

The sites where multiple aneurysm ruptures are not necessarily the sites where they most commonly occur. Among most of the series the most common site of aneurysm rupture was anterior communicating artery aneurysms

Heiskanen[28]	ACOM artery aneurysm	83%
	MCA aneurysms	43%
	ICA aneurysm	41%
T. Inagawa[8]	ACOM artery aneurysm	68%
	ICA aneurysm	40%
	MCA aneurysm	38%
	VBA aneurysm	20%

T. Inagawa[26]	ACOM artery aneurysm	50%
	MCA aneurysm	57%
	ICA aneurysm	46%
	VBA aneurysm	67%
Nehls et al [5]	ACOM artery aneurysm	62%
	PCOM aneurysm	50%
	ICA aneurysm	38%
	VBA aneurysm	50%
	MCA aneurysm	27%

Inagawa[4] noted higher probability of rupture among patients over the age of 59yrs (79%) compared to those younger than 59 (59%). Other aneurysms having a high probability of rupture were along internal carotid artery and vertebrobasilar distribution. Most authors reported a relatively low probability of rupture for middle cerebral artery aneurysms[5].

CLINICAL SIGNS:

In majority of the cases, the neurological examination is not helpful in localizing the site of aneurysm rupture. Nehls et al [5] noted that focal signs were present in only 9 of 94 patients. In only two of the nine patients were the clinical finding of value in helping to localize the site of aneurysm rupture. Almaani and Richardson[31] found the clinical examination to be of value in only 30% of patients with lateralising findings, for example optic nerve in ophthalmic segment aneurysm, oculomotor nerve in Pcom aneurysm, 3,4,and 6 nerve in cavernous sinus aneurysm and weber's sign in superior cerebellar artery aneurysm They

also reported that when EEG was combined with clinical examination, the site of rupture could be predicted with a 62% of accuracy.

C T SCAN:

Computed tomography can provide key information in localizing the site of aneurysm rupture. Non-contrast computed tomography could detect up to 90% of subarachnoid hemorrhage, when performed within 24 hour of rupture and is presently the best method for evaluating aneurysmal subarachnoid hemorrhage[5]. Focal collection of blood / hematoma or intraventricular hemorrhage correspond to specific aneurysm site, when multiple aneurysms are present. Recent reports found that computed tomography could localize the site of aneurysm rupture in only 45 to 55 % of cases [5].

Middle cerebral artery aneurysms account for up to 55% of all aneurysmal hematomas. These hematomas typically appear as coma shaped lesions in the sylvian fissure. Hematoma from proximally located MCA aneurysm and ICA aneurysm occur at temporal lobe and basal ganglia.

Posterior communicating artery aneurysms are typically oriented directly posterior, slightly lateral and downward and medial to the tentorial edge. Bleeding from aneurysms located in this position usually does not cause intracerebral hematoma, but produces a pattern of subarachnoid blood with in the suprasellar, perimesencephalic and ambient cisterns.

Anterior communicating artery aneurysms can produce a variety of hematomas. Blood may enter the third ventricle, through the lamina terminalis or it may enter the septum pellucidum directly through the midline creating a cavum septum

hematoma. Bifrontal intraventricular hemorrhage can occur, after rupture through the inferio-medial frontal lobe or less commonly, the corpus callosum. Unilateral gyrus rectus hematomas tend to occur opposite the side of dominant A – 1 as the aneurysm projects to opposite side.

Basilar bifurcation aneurysms can also produce intraventricular hemorrhage when blood enters through the floor of the third ventricle. These aneurysm may also produce focal hemorrhage in inter peduncular region.

PICA aneurysm rupture will cause bleed in the cerebello-pontine angle, or along the cerebellar vermis.Classical CT Scan picture is isolated blood in fourth ventricle.

MRI:

There is limited role for MRI in the evaluation of patients with sub arachnoid hemorrhage. MRI does not image acute sub arachnoid hemorrhage well, due to nonparamagnetic properties of oxyhemoglobin. It may be useful in studying sub acute or chronic sub arachnoid hemorrhage. MRI can reveal local edema and clot[32]. James and Robert et al [32] demonstrated that MRI could disclose multiple aneurysms as filling defects. MRI has revealed intraluminal clot in symptomatic cerebral aneurysm as small as 16 mm.

ANGIOGRAPHY:

Angiography is the most important test in evaluating intracranial aneurysms. High quality studies of all intracranial vessels with subtraction technique and additional

views as indicated, are essential in the evaluation of sub arachnoid hemorrhage. Angiographic signs that help in localizing the site of rupture are

1. Dye extravasations (smoking gun). Positively identify the site of rupture, but are highly uncommon and pretend an ominous course.[5]
2. Focal mass effect. (Highly reliable sign)
3. Focal vasospasm. (Highly reliable sign)
4. Aneurysm change on serial angiogram. (Highly reliable sign)
5. Aneurysm nipple
6. Irregular shape
7. Proximal aneurysm
8. Large aneurysm

There has been some controversy concerning the importance the aneurysm size and shape in predicting the site of rupture. Many others consider site alone to be the most important factor in determining the site of aneurysm rupture.[33] In an analysis of size versus irregularities, Nehl et al [5] found that the shape was the more consistent predictor of site of rupture. They found that the more irregular aneurysm was the site of rupture in 93.3% of cases and whereas the large aneurysm was responsible in 83.3% of cases. They recommended weighing the relative difference in the size and shape when trying to localize the site of hemorrhage

Akihoko Hino and Fugimeto et al [34] reported the site of prediction of rupture correctly in only 91% of cases before surgery. Nehls et al [5] found that the site of rupture could be determined with a 97.5 % accuracy using the following criteria.

1. Use focal CT hemorrhage to locate source of bleeding.
2. Look for highly reliable, but uncommon angiographic signs.
3. Weigh relative sizes and shape of aneurysm. Shape is usually more accurate in predicting the site of rupture.
4. Consider clinical or EEG finding to localize the side.
5. Obtain an MRI to look for focal edema or clot.
6. Repeat the angiogram at a latter date, to see if there is a serial change in any aneurysm.
7. Choose the aneurysm with highest probability of rupture.

TREATMENT

Patients with multiple aneurysms present a challenge, as opinions vary widely.

- Whether or not direct surgery should be performed on the unruptured aneurysm?
- Whether all the aneurysms should be clipped in one sitting or two sittings?
- Whether to operate and clip all aneurysms in older patients?

There are several studies, which have been carried out, to see the surgical outcome for multiple intracranial aneurysms. Opinions regarding surgical indications for multiple aneurysms have changed.

- McKissock et al [35] in 1964 and Paterson and Bond [36] thought that operation for unruptured aneurysm were not indicated.

- Heiskanen and Marttila [37] in 1970 advocated that only those unruptured aneurysms, which could be reached, through the same approach as for the ruptured aneurysm should be operated upon, and that a second operation would not be indicated.
- Hamby in 1959, Poppen and Fager in 1959, Moyes in 1971, Mount and Brisman in 1971 and in 1977 and Samson et al in 1977, recommended that if conditions were satisfactory, all surgically accessible unruptured aneurysms should be operated.
- Suzuki and Sakurai in 1979 and Solazar in 1980 and in 1983 insisted that all the multiple aneurysms should be considered for operation, even if a second operation was necessary to clip the unruptured aneurysm.

The natural history of hemorrhage from previously unruptured aneurysm is an unknown factor. Among those who have reported on the risk of subsequent bleeding from untreated, unruptured aneurysm in multiple aneurysm cases, the danger of such bleeding is said to be only 1-2 % per year [30]. Heiskanen[28] noted a yearly risk of rupture of 1% in 61 pts with multiple aneurysms in whom at least one asymptomatic lesion had not been clipped. Winn et al [38] reported an annual rupture rate between 1 & 2 % for similarly unsecured aneurysm and the mortality rate is said to be 4% over a 5 yr period.

Studies have shown that the morbidity and mortality for pts with multiple intracranial aneurysms following subarachnoid hemorrhage are attributable to the ruptured aneurysm, not the asymptomatic lesion. Brisman noted an overall

mortality of 56 % in pts with multiple aneurysm compared to 59% in pts with single aneurysm. Winn[38] (1983) found that there was a similar rate of rebleeding of 30% in pts with single or multiple aneurysms, in the latter group, the site of second hemorrhage was always rebleeding from the original ruptured aneurysm and never from an asymptomatic aneurysm, therefore, treatment should first be directed towards the symptomatic lesion.

The choice of surgical tactics is, decided upon in light of the location of multiple aneurysms and the serious risks of operating on asymptomatic unruptured aneurysms, which should be no greater than 3-4 %, and most of these risk concern morbidity and not mortality.[37,39,40]

It is generally agreed that all the aneurysms that can be reached using single surgical approach should be dealt with if technically possible, where as, when that is impossible the asymptomatic aneurysm should be dealt with the second operation. [41,42]

Most authors (Nehls and Armenda et al [5]) recommended clipping the asymptomatic lesion and clipping of all accessible aneurysms ,starting from deepest lesion and progressing superficially.

Difficulties can arise when clipping the symptomatic aneurysm first, as it would obscure the view of other deeper lesions or would interfere with subsequent clip application, in such cases, three options exists.

- The symptomatic lesion can be clipped or aspirated, and an attempt can be made to clip the deeper, asymptomatic lesion.

- Alternatively, the deeper lesion can be clipped, taking care not to disturb the ruptured aneurysm, which can be subsequently clipped.
- The deeper, asymptomatic lesion can be left untreated to be dealt with through another approach, if indicated and if possible the factors of aneurysm location and accessibility are weighed in making the decision.

When additional aneurysm cannot be clipped through a single approach, the unsecured lesions are treated like other incidental aneurysm if it has not ruptured.

Recent large series have addressed the role of one and two stage operations for patients with multiple aneurysms[26,39,43]. A single stage approach eliminates the need for additional surgery and ensures the aneurysm that ruptured has been clipped, even if it is incorrectly identified preoperatively. It eliminates the risk of hemorrhage from previously asymptomatic lesion, therefore, the aggressive treatment of vasospasm with induced hypertension and volume expansion is safer.

The advantage of two-stage approach is that the aneurysm exposure and clipping may be technically easier when subarachnoid blood has cleared and brain swelling has abated.

- Mizoi et al [43] have reported their experience in 372 cases of multiple aneurysms. When pts had multiple anterior circulation aneurysms or anterior communicating artery aneurysms in combination with anterior or posterior circulation, they were able to treat 90 % of them through single craniotomy. One session operation was successful in 60 % of pts with

bilateral aneurysms and 42% of pts with vertebrobasilar and anterior circulation aneurysms.

- Inagawa[26] favored a one stage operation and used a single operation in 71 %, and 16% were treated by two stage operation ie the ruptured aneurysm were treated upon and than the unruptured aneurysms were treated by second operation.
- Lester & Brisman[39] 1971, reported the experience in 70 pts of multiple intracranial aneurysms, with total of 160 aneurysms.110 aneurysm on internal carotid artery and 10 being on Intracavernous ICA, 31 on MCA, 16 on anterior cerebral artery or on anterior communicating artery and 4 on posterior circulation. In 43 patients, aneurysm was bilateral and in 27 pts it was unilateral. There were 56 patients with 2 aneurysms, eight with 3, five with 4 and one with 5 aneurysms. There were 20 patients with bilateral symmetrical aneurysm.(17 on ICA, and 3 on MCA).17 pts had nonsurgical treatment, and 22 had one aneurysm surgically treated. Twenty-five patients had both aneurysms treated by surgery, four had all three, one had all four and one had all five. 46 patients did not have all their aneurysms treated including 17 who had no surgical procedure at all. In this group good results are in 44%, poor in 35%, and death in 21%. Of the 24 patients who had all their aneurysms surgically treated by intracranial clipping, muscle wrapping, plaster spraying or extra cranial carotid ligation, 88% had good result, 8% had poor result and 4% died. The risk of

subarachnoid hemorrhage from an originally asymptomatic aneurysm is in between 10 - 20% in this series.

SURGICAL OUTCOME

- Peter & Moyes[40] (1971) reported his experience of (16%) 38 cases having multiple intracranial aneurysms. A total 87 aneurysms were present, 16 patients underwent two-stage operation. 9 patients died, before surgery could be offered to these patients. Out of 29 surviving patients 8 (27.6%) patients showed evidence of enlargement of untreated aneurysm or recurrent hemorrhage or both.
- Richard et al[38] evaluated the long-term outcome (average 7.7 yrs) in 182patients of multiple aneurysms. 132 patients were treated with bed rest and 50 by surgery (craniotomy). 70 patients with bed rest were alive after 6 months, 31 patients (30%)suffered a late hemorrhage. There was no evidence that previously intact aneurysm had ruptured in sub arachnoid hemorrhage patients treated with bed rest indicating that late hemorrhage was due to rerupture from the original aneurysm, hypertensive patients had increased risk of later hemorrhage. Of 50 craniotomy patients, 38 were alive after 6 months; in this group the risk of rupture from intact aneurysm was 1%.
- J Vajda[44] (1986) reported his experience of 138 cases of multiple intracranial aneurysms and found that the following distribution of aneurysms. (The distribution of aneurysm was same as that described by Nehls et al[5]).

- 2 aneurysms-108 patients.
- 3 aneurysms-23 patients.
- Incidence of triple aneurysms 12-19%.
- All patients. of 4 (4 patients) or 5 (1 patient) aneurysms were female
- 2 patients.had 6 aneurysms.
- Highest number of aneurysms: ICA, followed by MCA & ACOM.
- Out come (138 patients)

  Excellent outcome: 79 patients.

  Good outcome: 10 patients.

  Fair out come 13 patients.

  Disabled: 9 patients

  Died 27 patients.

T. Inagawa[8] 1990 reported his experiences of multiple intracranial aneurysms in 136 pts, with especial reference to elderly patients. Incidence of multiple intracranial aneurysms in his series was 28 %. Mean age was 59yrs. Male to female ratio was 64:36 %. The distribution was 72 % had 2 aneurysms, 20 % had 3 aneurysms and 8% had 4 aneurysms. These finding were similar to that Brisman et al series. 85 % of aneurysms were present in greater than 50 yrs of age and 46% in above 60 yr of age and 21 % were above 70 yr of age, he divided the pts in two groups.

- Group 1: Less than 59 yrs of age.

- Group 2: 60 yrs and more.

In both these groups, anterior communicating artery aneurysm rupture incidence was higher, especially in the elderly pts. Out come was assessed after 1 yr of subarachnoid hemorrhage.

Group 1:

- Grade I & II (33 pts): Good recovery (29), Moderate disability (0), Severe disability (3), Vegetative state (1) and Dead (0).
- Grade III & IIII (19 pts): Good recovery (12), Moderate disability (3), Severe disability (3), Vegetative state (0) and Dead (1).

Group 2:

- Grade I & II (22 pts): Good recovery (16), Moderate disability (2), Severe disability (1), Vegetative state (0) and Dead (3) pts.
- Grade III & IV (22 pts): Good recovery (12), Moderate disability (3), Severe disability (3), Vegetative state (1) and Dead (3) pts.

Group 1 had better results than group 2, regardless of whether one stage or two stage operation performed on multiple aneurysms.

Cause of death with in one yr after initial sub arachnoid hemorrhage:

1. Direct effects of aneurysmal rupture (leading cause of death).
2. Rebleeding.

3. Vasospasm.
4. Medical complications.

The incidence of multiple intra cranial aneurysms in elderly seems to be relatively low in males. Incidence of aneurysmal sub arachnoid hemorrhage increases linearly with age.

- T Inagawa[26] 1991 reported his experiences for pts with multiple intra cranial aneurysms especially those who were operated in early stage (total 126 pts). 2 aneurysms: 91 patients, 3 aneurysms: 24 patients, 4 aneurysms: 08 patients, 5 aneurysms: 02 patient, 6 aneurysms: 01 patient. About 28 % of patients constituted 3 or more aneurysms. These patients were grouped into three groups with those operated by single stage as group 1, those in two or more sittings as group 2 and those where only ruptured aneurysms were operated as group 3. The operative mortality in patients with multiple aneurysms was 10% in group 1, none in group 2, 14% in group 3.

The surgical results of multiple intracranial aneurysms were comparable to that of single aneurysms in group 1 patients, where as for those in group 2 and group 3 the results are better for multiple aneurysms than for single aneurysm.

- Mizori et al[43] reported that result of early one stage operation in pts with multiple intra cranial aneurysms were comparable to the results of those in patients with single aneurysm.
- J. Vajda [2] (1992) advocated the one stage complete repair of all lesions using both options of bilateral pterional craniotomies or the contra lateral

approach, but he also described that the silent aneurysms can be clipped safely, later on if they are not easily accessible during same sitting. Hazards and disadvantages concerning the more aggressive surgery proved to be less significant than the natural history of multiple aneurysm presents. He also showed in this study that surgical outcome in patients with single and multiple aneurysms do not differ significantly.

- Rinne et al [45] (1994) reported his experience of multiple intracranial aneurysms in a defined population from Finland. In his series incidence of multiple intra cranial aneurysms was of male predominance and half of these men had associated with hypertension. Intracavernous ICA and pericallosal aneurysms were more frequent (35%), and MCA (41%), vertebrobasilar only 5% and highest frequency for middle cerebral artery aneurysms (41%) and eight of these patients had mirror aneurysm.
- Jaakho Rinne & Juha [46](1995) reported their experience on the outcome for multiple intracranial aneurysms. The incidence of multiple intracranial aneurysms was 23%. 92% patients had presented with sub arachnoid hemorrhage, 5%(14) of patients presented with cranial nerve compression, hemiparesis, epilepsy or mass effect. In 3%(11) aneurysm was found incidentally. Middle cerebral artery aneurysms were the commonest (47%), followed by internal carotid artery (25%), and ACOM (16%), Vertebro-basilar (5%). Male predominance was found again in this series as that seen in earlier studies. 89% of patients with multiple intracranial aneurysms underwent surgery and 11% of patients were treated non-surgically (those with poor grade). Two

third of patients underwent single stage surgery with all aneurysms being treated. One third of patients were treated in two or more subsequent operations. Second surgery was performed usually at 8 to 10 weeks later.

This series showed that multiple intracranial aneurysms increase the risk for poor outcome, as compared to single intracranial aneurysm. The results of this series is comparable to that reported by Vadja et al

Inagawa, Mizori et al and Yasargil have reported there is no difference in surgical results between single and multiple aneurysms.

S. Kobayashi et al[30] (1996) reported their experience of surgical outcome for multiple intra cranial aneurysms in 221 cases.

1. 147 cases had multiple intra cranial aneurysms located unilateral in anterior circulation.
2. 44 cases located bilaterally in anterior circulation.
3. 30 cases located in both anterior and posterior circulation.

154 cases were operated in single stage, 18 cases in two stages and 49 cases underwent partial treatment (symptomatic or ruptured aneurysms only).

Postoperative follow up: 113 (51.1%) had excellent outcome, 48 patients (21.7%) had good outcome, 32 patients (14.5%) had fair outcome and 28 cases (12.7%) expired.

The results were comparable to the severity of the patients with those having single aneurysms operated during the same period.

They recommended that, all multiple aneurysms should be treated in one stage operation, in unruptured multiple intracranial aneurysms. Surgical management is

the recommended treatment. In poor grade subarachnoid hemorrhage patients, aged patients, and patients in bad general condition, surgical treatment of asymptomatic unruptured aneurysm should be considered carefully and it is this group of patients, where endovascular treatment of intracranial aneurysms can be valuable

RESULTS AND ANALYSIS

Of the 1083 operated patients for aneurysms, 120 patients (11%) had multiple aneurysms. There were 71 males and 49 females (table 1). The age group ranged from 18- 76 yrs (Table 2), peak incidence was seen in 5 & 6 decade . Systemic hypertension was present in 20 % of cases. There were total of 285 aneurysms in 120 patients.87 patients had 2 aneurysms, 23 patients had 3 aneurysms,8 patients had 4 aneurysms, and 2 patients had 5 aneurysms.(Table 3) The incidence of 3 or more aneurysms was 27.5% . The distribution of all aneurysms according to site is shown in table 4 .The commonest site of individual aneurysm was MCA (90), Acom (52), ICA (cavernous, ophthalmic and ICA bifurcation)(59), Pcom (43), DACA (14), Ach (11), and posterior circulation (16) aneurysms.(mainly at basilar bifurcation (6), and basilar trunk (6)).Aneurysms of anterior circulation out numbered that of posterior circulation, anterior-posterior ratio being 16.:1. . 17 patients had mirror aneurysms,. The commonest being MCA bifurcation (11), Pcom (4), and ICA ophthalmic segment (2) patients (. table 5 .).

There were 23 giant aneurysms (ICA 12, Acom 4 ,MCA 4).and 48 large aneurysms (MCA 15,Acom 14, ICA 7) .Aneurysms at Acom and MCA bifurcation were most frequent , followed by Acom –ICA ,MCA –ICA ,and MCA – Pcom.All patients except two, presented with subarachnoid hemorrhage .(one patients presented with progressive deteriorating vision and was investigated and found to have Pcom and Acom aneurysm and second patient had CVA and

hemiparesis and was found to have MCA aneurysm. Other associated features were seizures in 19 patients , focal neurological deficits in 15 patients(3 ,6and 7 nerve palsy, hemiparesis and papilloedema).Hydrocephalus was seen in 21 patients .Hypertension was present in 24 patients. History of warning leak was present only in 2 patients .The majority of patients (111) were in WFNS grade one constituting 92.5 % of all, 4 patients were in grade two, 2 patients were in grade three and 3 patients were in grade four.

According to Fischer's grading, 39 patients (32.5%)were in grade one, 51 patients (42.5 %)in grade two, 10 patients (8.3 %) in grade three and 20 patients (16.6%) were in grade four. Only 18 patients out of 111 patients of WFNS grade one had angiographic vasospasm, in grade two, none had vasospasm, in grade three, one had vasospasm, and in grade four , two patients had vasospasm ..All the 120 patients underwent operation .75 patients were operated within first week of subarachnoid hemorrhage and 45 patients after the first week. 84 % and 78.5% patients had excellent or good out come in above groups respectively,(Table9). There were 114 aneurysms on the left side, 107 aneurysms on the right side and 64 aneurysms in the mid line .The most common site for rupture was Acom aneurysm in 39 patients, ICA in 38 patients, MCA in 32 patients while in posterior circulation only 2 aneurysms had bled..89 patients had undergone single surgical procedure and 141 aneurysms were clipped, 11 patients underwent two craniotomies in single sitting and 27 aneurysms were clipped, while 20 patients underwent a second craniotomy at a later date and 51 aneurysms were clipped Patients requiring two craniotomies in

the same sitting were mainly associated with either contralateral aneurysm or a DACA aneurysm. 20 patients, who underwent stage procedure, had 30 aneurysms clipped in first sitting and 21 aneurysms clipped in second sitting and one aneurysm was coiled. (Time interval 4 days to 2 months) .19 aneurysms (15 patients) were left untreated in single craniotomy group. 11 of these had single aneurysm and 4 patients had 2 aneurysms .Of the 19 aneurysms, 15 were in anterior circulation and 4 in posterior circulation. Aneurysm size was very small in 12 patients and it was decided to keep them in regular fellow up, in 7 aneurysms it was decided to be tackled at a later date. These patients lost to follow up. No aneurysms were left untreated in 2 and 3 group that is (patients who under went two craniotomies in single sitting or second surgery as a stage procedure).

Majority of patients underwent pterional craniotomy (105 patients), while 12 patients underwent large frontotemporal craniotomy, 2 patients had bifrontal craniotomy, and one patient combined approach. (Supratentorial and infratentorial). While 219 aneurysms were clipped, 40 aneurysms were just coagulated and wrapped with muscle. Other procedures performed were, trapping and sephanous vein bypass graft, trapping and excision and coiling. Of the 120 patients, 105 patients had all aneurysm clipped and in 15 patients one or two aneurysm were left untreated. Of which 4 were in posterior circulation. Aneurysms which were wrapped and coagulated have not had further subarachnoid hemorrhage on prolong follow-up..

Fourteen patients had hemi paresis postoperatively, of which 10 patients already had deficit preoperatively. Ten patients showed improvement subsequently on

follow-up, while in 4 patients no improvement was noted. (2 patients each from preoperative and postoperative group). Other complication were 3rd nerve palsies in 9 patients (three had permanent palsy), seizures in 5, transient CSF rhinorrohoea 3 patients, aphasia one patient which improved on follow-up, hydrocephalus developed in 8 patients, of which 3 required VP shunt, 6th nerve palsy in 6 patients, EDH in one and two patients needed decompressive surgery for massive infarction .Out come was assessed by Glasgow outcome scale (GOS) .Excellent outcome could be achieved in 82 patients 21 patients ,moderately disabled, and 5 were severely disabled.

Out of 82 patients with excellent out come, 79 patients were of WFNS grade 1 preoperatively, two patients were in grade2, and one patient was in grade 4.In moderately disabled group, out of 21 patients 17 were from WFNS grade 1 preoperatively, Two each from grade 2 and 3. Five patients who were severely disabled post operatively all were from WFNS grade 1(Table10). Surgical outcome was found to be excellent in younger age group (0-30 years) i.e. 85.7%, while in middle age group (31-50yrs), and elderly age group (51-80 yrs) excellent out come was noted in 72% and 66% respectively (table8). Over all excellent or good out come was noted in 62(86%) male patients and 41 (83.6%) female patients .In single surgery group, of the 89 patients, excellent out come was noted in 62 patients, good in 13 patients, fair in 4 patients and 10 patients expired. In group two (, 11 patients), where two surgeries were performed in same sitting, 6 patients had excellent out come, and good outcome in 3 , 2 patients expired in this group .In group three, (20 patients),where stage surgery

was performed ,excellent out come achieved in 14 patients ,good in 5 patients and fair in one patients ,There was no death in this group.

There was a mortality of 12 patients of which 10 patients were in WFNS GRADE 1 and 2 patients in grade 4 preoperatively. The mortality was higher in patients who were having more than two aneurysms .The mortality in patients having two aneurysms was 8 %, those having 3 aneurysms was 13% and those having 4 aneurysms was 25% (Table: 12 & 14). The causes of mortality were ischaemic neurological deficit in 7 patients, pulmonary edema 2 patients, septicemia 2 patients and hemorrhagic infarct in pons and medulla 1 patient.

The mean follow up was 24 months after the surgery (range of follow-up 2 months to 60 months). Of 108 patients 82 patients were available for follow up, 25 patients were lost to follow up and 1 patient expired during follow up (unrelated to surgery). All the patients were in excellent health and back to normal activities. Three patients developed features of normal pressure hydrocephalus which needed thecoperitonial shunt. Two patients improved in the hemi paresis at follow up.

TABLES

Table 1-Sex Distribution

Sex	No of patients	Percentage
Male	71	59.16%
Female	49	40.84%

Table 2-Distribution of patients in decades: -

Age(yrs)	No.of patient
0-9	0
10-19	3
20-29	2
30-39	18
40-49	41
50-59	32
60-69	22
70-79	2

Table 3 - Multiplicity of Aneurysms

No of patients	No. of aneurysm	Total no of Aneurysms-285
87	2	174
23	3	69
8	4	32
2	5	10

Table 4- Location of Aneurysms

site	No. of aneurysm
MCA	90 (31.5%)
ACOM	52 (18.2%)
ICA(cavernous,ophth segment&ICA bifurcation)	59 (20.7%)
PCOM	43(15%)
DACA	14 (4.9%)
ACH	11 (3.85%)
Post. Circulation	16 (5%)

Table 5 - Mirror Aneurysms

site	No.of patients
MCA Bifurcation	11
PCOM	4
ICA Ophthalmic segment	2

Table no 6 : Surgical outcome in male and female patients

Count of Name	Surgical outcome				
Sex	Excellent	Expired	Fair	Good	Grand Total
Female	34	5	3	7	49
Male	48	7	2	14	71
Grand Total	82	12	5	21	120

Table no:7 Surgical outcome in different age groups and sex .

Count of Name		Surgical outcome				
Sex	age distri	E	Ex	F	G	Grand Total
Female	0(0-30yrs)	2	1			3
	1(31-50yrs)	17	1	1	3	22
	2(51-80yrs)	15	3	2	4	24
F Total		34	5	3	7	49
Male	0	4				4
	1	32	7	2	5	46
	2	12			9	21
M Total		48	7	2	14	71
Grand Total		82	12	5	21	120

Table No: 8: Surgical outcome in different age groups.

Count of Name	Surgical outcome				
age distribution	E	Ex	F	G	Grand Total
(0-30 yrs)	6(85.7%)	1			7
(31-50yrs)	49(72%)	8	3	8	68
51-80yrs)	27(60%)	3	2	13	45
Grand Total	82(68.3%)	12	5	21	120

Table No : 9 Surgical out come in-early and delayed surgery

Count of Name	Surgical outcome				
SURGERY	E	Ex	F	G	Grand Total
Early surgery1	47	8	4	16	75
Delayed surgery2	35	4	1	5	45
Grand Total	82	12	5	21	120

Table No :10 Over all surgical outcome

Count of Name	Surgical outcome				
WFNS-grade	E	Ex	F	G	Grand Total
Grade1	79	10	5	17	111
Grade2	2			2	4
Grade3				2	2
Grade4	1	2			3
Grand Total	82	12	5	21	120

Table No. 11 Distribution of aneurysm in expired patient

		No of Aneurysm				
Expired	WFNS-Grade	2	3	4	5	Grand Total
Expired	Grade1	6	2	2		10
	Grade4	1	1			2
Expired Total		7	3	2		12
(blank)	1	75	19	5	2	101
	2	3		1		4
	3	2				2
	4		1			1
(blank) Total		80	20	6	2	108
Grand Total		87	23	8	2	120

Table No: 12 Surgery performed in different group (in expired patients)

Count of Name		Type of Surgery			
Expired	No of Aneu	Group1	Group3	Group2	Grand Total
Ex	2	7			7 (8%)
	3	2		1	3 (13%)
	4	2			2(25%)
Ex Total		11		1	12
(blank)	2	59	13	8	80
	3	13	6	1	20
	4	5	1		6
	5	2			2
(blank) Total		79	20	9	108
Grand Total		90	20	10	120

Group1-Single sitting one craniotomy
Group2-Single sitting two craniotomy
Group3-Stage surgery

Table No: 13 Aneurysm left in expired patients

Count of Name	Expired		
Aneu Left-1	Ex	(blank)	Grand Total
BT		2	2
Ic-caver		1	1
Ic-It-intracaver		1	1
Ic-rt-Op		1	1
Mc-bif-It		1	1
Mc-Is		1	1
Mc-It		1	1
Mc-rt-bif		2	2
N	12	93	105
Op-It		1	1
P2P3		1	1
rt-Mc-bif		1	1
Y-P1P2,Ic-It		1	1
Y-Pm-rt-s		1	1
Grand Total	12	108	120

No aneurysm was left in expired patients

Table no:14 Surgical outcome depending upon number of aneurysms

Count of Name	Surgical outcome				
No of Aneu	E	Ex	F	G	Grand Total
2	63	7	2	15	87
3	14	3	2	4	23
4	3	2	1	2	8
5	2				2
Grand Total	82	12	5	21	120

Table No 15 Surgical outcome depending upon WFNS grade and number of aneurysms.

Count of Name		SURGICAL OUTCOME				
No of Aneurysms	WFNS Grade	E	Ex	F	G	Grand Total
2	1	61	6	2	12	81
	2	2			1	3
	3				2	2
	4		1			1
2 Total		63	7	2	15	87
3	1	13	2	2	4	21
	4	1	1			2
3 Total		14	3	2	4	23
4	1	3	2	1	1	7
	2				1	1
4 Total		3	2	1	2	8
5	1	2				2
5 Total		2				2
Grand Total		82	12	5	21	120

DISCUSSION

The incidence of multiple intracranial aneurysms ranges from 5 to 33.5% depending mainly on the completeness of diagnostic procedure[29,35,42,43]. In general, the incidence of multiple intracranial aneurysms is little higher in autopsy series than in clinical studies[3,35].

The natural history of unruptured aneurysms in cases of multiple aneurysms, especially the risk of rupture is not precisely known[47]. Jane[48] and wine[38] et al speculated that the annual risk of unruptured asymptomatic aneurysms were similar to the natural history of healed ruptured aneurysms. In patients with multiple aneurysms, risk of bleeding from unruptured aneurysms has been described as 10-17%[48]. According to Heiskanen[28] and Winn[38] et al in patients with multiple aneurysms, the annual risk of rupture of aneurysms is apparently 1% per year and mortality rate is said to be 4% over a 5- year period. Wiebers et al [26] in a clinical study reported that unruptured saccular aneurysms of less than 10 mm in diameter have a very low probability of subsequent rupture. On the contrary, Kassel and Torner [51] stressed that unruptured aneurysm of less than 10 mm in diameter could not be considered innocuous and that operation should be considered for aneurysms more than 5 mm in diameter.

It is generally accepted that surgical treatment of ruptured intracranial aneurysms is superior to any other form of therapy. Although it seems clear that surgery for silent aneurysm is much safer[42]. Some argue that even the lowest

morbidity and mortality figures after such operations are higher than the threat presented by those aneurysms[38]. Opinions are still divided on these matters, but growing evidence now points in favour of an aggressive attitude towards the treatment of silent aneurysms[28, 29,49]. Now there is worldwide opinion in the literature to recommend the clipping of all aneurysms in cases of multiple intracranial aneurysms (Hamby [2]1959, Popper and Frazer[49] 1959, Pool and Poths[2] 1965, Mount and Brisman[39] 1971, Moyes[40] 1971, Heiskanen[28] 1981.)

Regarding the gender of patients with multiple intracranial aneurysms, most of previous studies have shown a preponderance of females, that is multiple aneurysms were up to five times more frequent in females than males.[3, 5,29,44]. Contrary to this in our series, males predominated (71 patients) than females (49 patients). Only two series reported a slight male preponderence.[2]

According to Nehl's[5] et al, 72% of the patients with multiple intracranial aneurysms were over 50 years of age and 16% were 70 years of age or older, while other authors have reported about 60% of patients with multiple intracranial aneurysms were in their in fifth and sixth decade.[3, 44]. In this study also, 61% of the patients with multiple intracranial aneurysms were in the fifth and sixth decades. According to several studies, the incidence of aneurysmal subarachnoid hemorrhage increases almost linearly with the increase in age[3].

The incidence of multiple intracranial aneurysms in this study (11%) stands at the lower end of range presented in the literature which is about 5 - 44% [1,2]. J Vajda [44]1986,also reported low incidence (14%) of multiple intracranial

aneurysms in his series. He attributed this, to lack of regular vigorous preoperative angiography in earlier days

In this study 72.5% (87 patients) had two aneurysms, 19% (23 patients) had 3 aneurysms and 8.5% had more than 3 aneurysms. These findings are similar to that reported by T Inagawa[26] (1990), Brisman and Kobayashi[30].

Multiple aneurysms are seen at usual sites as that for single aneurysms. Most common sites for multiple aneurysms is along the ICA and middle cerebral artery bifurcation.

In this study, the location of aneurysms were as fellows

ICA	:40%
MCA	:32%
ACOM	18%
ACA	:5%
Vertebrobasilar territory	:5%.

These results are similar to other series reported in literature. T Inagawa [26](1991) and Wilson[1] and Bjorkesten and halonen[27], Nehls [5].

Mirror aneurysms are reported in upto 40% of cases and are especially common at the MCA (Anderson[25]), but in this study the incidence of mirror aneurysms was found to be 14% and MCA (64%) bifurcation region was the commonest followed by PCOM and ICA bifurcation. The posterior circulation aneurysm in this study was 5%, similar to other studies as reported by T Inagawa,[26] Kobayashi[30].

All patients except two, presented with subarachnoid hemorrhage in this series (98.4%), which is higher as compared to other series reported: Kobayashi [31]reported 73.3%, J Rinni [46] et al 92%. Majority of patients were in WFNS grade 1 , one hundred and eleven patients (92.5%), while four, two and three patients were in grade 2, 3 and 4 respectively

Angiography is the most important test in evaluating intracranial aneurysms. Nehl's et al [5] described angiographic signs in localizing the site of rupture. Highly reliable signs include focal vasospasm, focal mass effect from a hematoma or changes in the shape of an aneurysm on serial angiogram. They still consider the importance of aneurysm size and shape controversial in predicting the site of rupture.[5]

In this study, the most common site of rupture was ACOM followed by ICA and MCA bifurcation. Only two aneurysms of posterior circulation ruptured, which is similar to other series reported in literature[8, 43].

There were 64 midline aneurysms, 114 on left side and 107 on right side. There were several combinations of aneurysms, including multiple aneurysms of the same artery, unilateral ICA aneurysm combined with MCA aneurysm and ACOM artery aneurysm in combination with DACA aneurysms. Majority of such patients underwent single stage procedure and all accessible aneurysms were clipped. Total 141 aneurysms were clipped in single stage procedure.

In group two where two craniotomies were performed in same sitting and a total of 27 aneurysms were clipped.

In third group, staged surgery was performed, the second surgery being done at the interval of 4 days to two months. A total of 51 aneurysms were clipped altogether with 21 aneurysms were clipped in second sitting.

According to T. Inagawa in patients with multiple intracranial aneurysms, whose unruptured aneurysms are small and are readily accessible, the risk of dissection or clipping of unruptured aneurysms seems to be basically similar to that as for removal of clots surroundings the arteries. Therefore when extensive clot removal is intended and unruptured aneurysm are present in cisterns containing severe clots, the clipping of unruptured aneurysms seems to be indicated[26].

When the additional aneurysms are not on the same side as a target one, various approaches can be combined[26]. Basilar aneurysms, either ruptured or unruptured, are in a delicate position as they are constrained by limited space and the vital structures and thus have the priority in governing surgical strategy. If the aneurysm is on the pericallosal artery of either side, an appropriate clipping is always feasible by a parasagittally extended craniotomy planned for the target aneurysm.

The most regularly used frontotemporal craniotomy allows clipping of contralateral carotid aneurysm at the PCOM artery and ICA bifurcation. also Ophthalmic artery aneurysms are even easier to expose from the contralateral side because the entrance of the internal carotid exhibit itself better to other side[2]. In some ideal cases even the contralateral MCA trunk can be explored and aneurysm there can be clipped using the pterional craniotomy well extended to the base with out significant increase of frontal lobe elevation[2].

Hazards of contralateral approach constitute the limited proximal control , limited space for dissection and depth .The optic nerve hampers the clipping in certain cases and excessive retraction of frontobasal lobe might evoke loss of olfaction.

More craniotomies in one sitting represent just theoretical disadvantages. All risks related to the craniotomy (large exploration, incidence of infection or epilepsy) may be doubled with two craniotomies in addition to the risk related to the anesthesia . Hazards related to incomplete or complete treatment are much more significant. If all aneurysms are clipped in a single surgery, it may compromise more vessels, the incidence of ischaemia may increase due to vasospasm. On the other hand if, repair has been incomplete, there is risk of rerupture. This may be caused by improper clipping or. when the other aneurysm hampered the exposure or the aneurysm was unrecognized [26].

There are cases in which contralateral approach of a MCA aneurysm is not feasible. If the aneurysm on both sides are fairly large and the MCA branches are adherent to the sac, it is rather hazardous to dissect from the contra lateral side, therefore these aneurysms have to be clipped with two craniotomies either in single sitting or as a staged procedure.

Now at majority of centers [2] it is the policy of clipping all accessible aneurysms during a single operation, based on experiences with rupture or rerupture from aneurysm left unclipped[44]. Contralateral aneurysms may be clipped at later surgery, for those aneurysms that are small and regular in shape, provided the patients blood pressure is controlled well. However recent studies have reported that hypertension and hypervolemia do not seem to increase the changes of

hemorrhage from unsecured, unruptured aneurysms in the acute setting or in their short term natural history [50]

Combinations of aneurysms of the circle of willis and distant from it, eg:, on peripheral posterior inferior cerebellar artery may require not only two different approaches but staged surgery .

Consequently although the surgical risk of direct operations for multiple intracranial aneurysms seems to be similar to that of operation for single aneurysm. Several factors such as patients clinical condition and age and the site and size of the unruptured aneurysm should be taken into consideration before operating on the aneurysms[26].

T Inagawa [8] 1990 had also shown that even in elderly pts with multiple intracranial aneurysms, the surgical outcome seems to be similar to that for pts with single aneurysm.

In this study 19 aneurysms were not clipped in single stage procedure because they were either relatively small or inaccessible, arising from C3 or C4 portion of ICA.

Kassel and Torner [51] stressed that unruptured aneurysms of less than 10 mm in diameter could not be considered innocuous and that operation should be considered for aneurysms more than 5 mm in diameter In this study also none of our patients had rebleed (the size being less than 5 mm), also in a staged procedure group, where 21 aneurysms were clipped over an interval of 4 days to 2 months, none had rebleed.

In this study,82(68.3%) patients had excellent out come ,21(17.5%) patients had good out come ,5(4.1 %) patients fair outcome and 12 (10 %) patients died. These results are nearly similar to as reported by Kobayasi[30] and T.Inagawa.[26] The mortality in this series was 10% for multiple intracranial aneurysms while overall mortality was 6%(among 1083 patients). Kobayasi[30] reported mortality of 12% and 11.2% in multiple and single intracranial aneurysm respectively.T Inagawa[26] also reported similar results .contrary to this J.Rinne[46] and J.Vajda[44] et al reported a higher incidence of mortality 16% and 19% respectively in multiple intracranial aneurysms It was also noted that those patients having more than two aneurysms ,had a higher mortality rate , than the patients having two aneurysms which contradict to Kobayasi[30] results ..In the 20 patients of group 3 , there was no surgical deaths. several authors have reported that there is no operative mortality in patients with unruptured asymptomatic aneurysms treated by elective surgery[39,42,47] The outcome was much better with the preoperative clinical grade of the patient. The patients with poor grades, 66 % had died, while only 9 % patients had died with good grades. Kobayasi [30]et al have showed similar results. So the most important factor determining the surgical outcome in subarachnoid hemorrhage patients is the preoperative clinical grades. As regards to timing of surgery ,75 patients (62.%) were operated within first week from initial SAH and 45 patients (38%) operated after the first week The causes for this late surgery were mainly delayed referral to our institute and in patients with associated medical disease .there was no significant difference according to timing of surgery and this was also found by Inagawa [26],Rinne [46]et al .Surgical

out come was better in younger age group patients than older patients . There was no difference in surgical outcome of male and female patients overall. This also may indicate the importance of early operation of unruptured aneurysm as no one can tell whether these aneurysms will rupture or not and if they rupture, which grade the patient would present with.

CONCULSIONS

Based on our results we conclude that

1.In unruptured multiple intracranial aneurysms cases surgical management is the recommended treatment.

2. Through out come partly depends on number of aneurysms, but the most significant variable influencing the out come of the patient with multiple intracranial aneurysms with subarachnoid hemorrhage is the preoperative clinical grade.

3.When ever possible all multiple aneurysms should be treated as a single stage procedure

4..Surgical outcome is better in younger age group patients than older age group patients.

5.There was no significant difference in surgical out come in male and females..

6. No significant difference in outcome was found between early and delayed surgery

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