Vasospasm: A friend or foe - initial experience

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ABSTRACT

Background: The optimal time to operate on an intracranial aneurysm eludes a satisfactory answer. While most surgeons would agree to operate early in young and neurologically intact patients, the ideal timing in older and neurologically impaired patients is debatable. In India, the majority of centers operate on patients in Hunt and Hess grades I-III, but is circumspect about grades IV and V. **Purpose:** The following study was carried out to check the effect of vasospasm on mortality rates and time of surgery being performed on the patient after having the same in patients coming under criteria of Hunt and Hess grades IV and V **Methods:** We undertook a prospective evaluation of 171 consecutive patients of aneurysms operated during the last 9 years irrespective of their age, neurological grade, and time of presentation or vasospasm in an attempt to resolve this issue. The influence of vasospasm on each neurological grade was examined. **Results:** It appears that concomitant presence of vasospasm in grade III, IV and V patients indicates a possible "reversible" cause of the poor neurological status, while its absence may indicate an irreversible or more extensive primary insult. C**onclusion:** The presence of vasospasm in poor grade patients appears to be a better prognostic indicator.

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Introduction

The suitable time to operate on an intracranial aneurysm awaits comprehensive investigation. While most surgeons would agree to operate early in young and neurologically intact patients, the ideal timing in older and neurologically impaired patients is debatable.[1,2]

Norlen and his colleagues suggested that surgery should be delayed beyond the third week of bleed.[3] Later, Pool advocated early surgery in the young patients.[3,4] In 1990, the cooperative study on SAH concluded that early surgery was neither beneficial nor hazardous compared to a delayed intervention. The outcome was found to be worse if surgery was performed 7 to 10 days after the bleed.[5]

In India, the majority of centers operate on patients in Hunt and Hess grades I-III, but are circumspect about grades IV and V.[6]

We undertook a prospective evaluation of 171 consecutive patients of aneurysms operated during the last 9 years at Sanjay Gandhi Postgraduate Institute irrespective of their age, neurological grade and time of presentation or vasospasm in an attempt to resolve this issue. The influence of vasospasm on each neurological grade was investigated. The presence of vasospasm in poor grade patients appears to be a better prognostic indicator.

Methodology

One hundred and ninety nine consecutive patients, with 234 aneurysms, presented to us in the last 9 years. Of these, a single surgeon (VKJ) operated upon 171 patients. The total number of aneurysms in these patients was 200, of which 193 were treated surgically. Eight patients died during the preoperative period. Two patients with mycotic aneurysms were treated with antibiotics and one patient underwent embolization of an intrapetrous aneurysm. Seventeen patients were not operated upon either due to lack of consent or being in a moribund status (bilateral decerebrate response).

All the patients came with a working diagnosis of subarachnoid haemorrhage (SAH) and underwent an urgent 4 vessel angiogram irrespective of the neurological grade. Patients were operated on as soon as possible and within 24 hours of admission. Neurological assessment at admission, prior to surgery, and at one month after discharge from the hospital, was done using the Hunt and Hess scale.[7] As per this scale, patients were shifted into the next worse category, if they had angiographic vasospasm or past history of essential hypertension, diabetes mellitus, severe atherosclerosis or chronic obstructive pulmonary disease. Vasospasm was evaluated only on the basis of angiogram as per the criteria laid down in the cooperative trial.[5] The follow up after six months or beyond was done using the Glasgow outcome scale. Study was approved by ethical committee.

Results

Out of 171 patients operated upon, 161 had a history suggestive of SAH. Ten (5.8%) patients presented with focal neurologic signs without any bleed. The locations of the 193 surgically treated aneurysms and their outcome are shown in Table I. Eighty two (42.4%) out of the 90 aneurysms on anterior cerebral artery were from the anterior communicating artery (ACom a), 25 (13%) out of the 60 ICA aneurysms were from (IC-PCom A) and 3 each out of the 13 in the posterior circulation were from the distal basilar artery and the posterior cerebral artery. Twenty four (14.0%) had multiple aneurysms, of which 19 had double and 5 had triple aneurysms.

Table I: Sites of aneurysms

Site	n
Anterior cerebral artery	90 (46.6)
Middle cerebral artery	30 (15.5)
Internal carotid artery	60 (31.0)
Vertebrobasilar artery	10 (5.2)
Posterior cerebral artery	3 (1.5)
TOTAL	193

Figures in parentheses denote percentage

The age range of the patient was from 11 to 80 years, with a mean age of 44.29 (± SD 14.16) years. The mortality was 37.5% in patients older than 65 years and 21.6% in patients between 50 to 65 years. The male-female ratio was 1:1. Out of the 193 aneurysms, 15 were giant (> 25mm), 33 large (12-24 mm) and rest were small.

CT Findings and Vasospasm

The extent of subarachnoid hemorrhage in CT scan was graded as per Fisher's Criteria.[8] Mortality was found to be 3.8%, 14.3%, 18.2% and 22.4% in Fisher's grade 1to 4 respectively **(Table II)**. There were no cases of diffuse spasm in Fisher I, while it was 25.7%, 33.3% and 25.4% in Fisher's 2, 3 and 4 respectively. The incidence of focal spasm was 26.7% and diffuses spasm 23%. Mortality rose from 14.0% in focal spasm to 21.6% in diffuse spasm **(Table III)**. Mortality was 16% in patients without spasm as all the giant aneurysms who died were in this group. In other words Fisher's grade, vasospasm and mortality had a linear relationship.

Timing of surgery, preoperative grade and vasospasm

The timing of surgery with its outcome and preoperative grading of patients in the various intervals is given in **table IV and V** respectively. 47.4% of patients were received in poor grade (IV and V) in less than 4 days bleed surgery interval and it progressively reduced to 20% in > 2 weeks interval. These trends are reflected in the operative mortality with mortality of 36.8% in < 4 days reducing to 10% in > 2 weeks interval. Diffuse vasospasm was present in 15.7% between 0-3 days, 40% between 4 to 6 days, 38.9% between 7 to 10 days, 25.0% between 11 to 14 days and 23.3% in more than 14 days post SAH in the present series. It does not seem to have translated into a higher mortality in these groups of patients. In contrast to the cooperative series data[5], our mortality was less (13.9%) in the 36 patients operated in the 7-10 day post SAH interval with an incidence of 37% diffuse spasm compared to patients operated prior to day 7 post SAH (Table IV). It was least (6.3%) in 11-14 days interval. The outcome of patients at the time of discharge with respect to their preoperative Hunt and Hess grade is shown in **table VI**. The cor-

Table II: Fisher's grade on CT scan and outcome

Fisher Grade	n*	Outcome grade (Hunt and Hess)					
		I	II	III	IV	V	Dead
1	26	17-(65.4)	4-(15.4)	2-(07.7)	2-(07.7)		1-(03.8)
2	35	11-(31.4)	8-(22.9)	6-(17.1)	4-(11.4)	1-(2.9)	5-(14.3)
3	33	6-(18.2)	12-(36.4)	3-(9.1)	4-(12.1)	2-(6.1)	6-(18.2)
4	67	11-(16.4)	11-(16.4)	12-(17.9)	14-(20.9)	4-(6.0)	15-(22.4)
Total	161	45-(28.0)	35-(21.7)	23-(14.3)	24-(14.9)	7-(4.3)	26-(16.15)

* 10 patients without history of bleed excluded. Figures in parentheses indicate percentages

Table III: Angiographic vasospasm and outcome

Vasospasm	n*	Outcome grade (Hunt and Hess)					
		I	II	III	IV	V	Dead
None	81	34(42.0)	16(19.8)	10(12.3)	8(9.9)	--	13(16.0)
Focal	43	6(14.0)	11(25.6)	9(20.9)	9(20.9)	2(4.7)	6(14.0)
Diffuse	37	5(13.5)	8(21.6)	4(10.8)	7(18.9)	5(13.5)	8(21.6)
Total	161	45(28.0)	35(21.7)	23(14.3)	24(14.9)	7(4.3)	27(16.8)

* 10 Patients without history of bleed excluded. Figures in parentheses indicate percentage

Table IV: Timing of surgery and outcome

Bleed Surgery Interval in Days	n*	Outcome grade (Hunt and Hess)					
		I	II	III	IV	V	Dead
< = 3	19	6-(31.6)	3-(15.8)	1-(05.3)	2-(10.5)		7-(36.8)
4 – 6	30		8-(26.7)	3-(10.0)	9-(30.0)	2-(06.7)	8-(26.7)
7-10	36	8-(22.2)	7-(19.4)	5-(13.9)	9-(25.0)	2-(05.6)	5-(13.9)
11-14	16	4- (25.0)	5-(31.3)	3-(18.8)	1-(6.3)	2-(12.5)	1-(6.3)
> = 15	60	27-(45.0)	12-(20.0)	11-(18.3)	3-(05.0)	1-(01.7)	6-(10.0)
TOTAL	161	45-(28.0)	35-(21.7)	23-(14.3)	24-(14.9)	7-(04.3)	26-(16.1)

* 10 patients without history of bleed excluded. Figures in parentheses indicate percentages

Table V: Timing of surgery and preoperative grade

Bleed Surgery Interval in Days	n*	Preoperative grade (Hunt and Hess)				
		I	II	III	IV	V
< = 3	19	4 - (21.1)	2-(10.5)	4-(21.1)	4 - (21.1)	5-(26.3)
4 - 6	30		6-(20.0)	3-(10.0)	14 – (46.7)	8-(26.7)
7-10	36	7-(19.4)	7-(19.4)	3-(08.3)	11-(30.6)	8-(22.2)
11-14	16	1-(6.3)	5-(31.3)	3-(18.8)	5-(31.3)	2-(12.5)
> = 15	60	19-(31.7)	19-(31.7)	10-(16.7)	10-(16.7)	2-(03.3)
TOTAL	161	31-(19.3)	39-(24.2)	22-(13.7)	44-(27.3)	25-(15.5)

*10 patients without history of bleed excluded. Figures in parentheses indicate percentages

Table VI: Preoperative grade with vasospasm and outcome

Preop Grade	n	Outcome grade (Hunt and Hess)					
		I	II	III	IV	V	DEAD
I With spasm	0	0	0	0	0		0
Without spasm	36	28-(77.8)	1-(02.8)	3-(08.3)	2-(05.6)		2-(05.6)
II With spasm	22	5-(22.7)	12-(54.5)	4 – (18.2)			1-(04.6)
Without spasm	19	6-(31.6)	12-(63.2)				1-(5.3)
III With spasm	9	5-(55.6)	2-(22.2)	1-(11.1)			1-(11.1)
Without spasm	16	3-(18.8)	2-(12.5)	5-(31.3)	2-(12.5)		4-(25.0)
IV With spasm	27		2-(07.4)	8-(29.6)	9-(33.3)	3-(11.1)	5-(18.5)
Without spasm	17	2-(11.8)	2-(11.8)	2-(11.8)	6-(35.3)		5-(29.4)
V With spasm	22	1-(04.6)	3-(13.6)		7-(31.8)	4-(18.2)	7-(31.8)
Without spasm	3						3-(100.0)
TOTAL	171	50-(29.2)	36-(21.1)	23-(13.5)	26-(15.2)	7-(4.1)	29-(17.0)

Figures in parentheses indicate percentage

relation of vasospasm and preoperative neurological grade with outcome is shown in table VI. The mortality in grade II patients was not found to be altered with the presence or absence of vasospasm. However, in drowsy and unconscious patients (grade III-V) mortality is more in patients without vasospasm. Out of 69 patients in grade IV and V, the operative mortality was 22.7% and 40% respectively. Follow up of 6 months to 8 years was available in 101 patients and is given in **table VII**.

Discussion

Early aneurysm surgery has been variously defined as up to 21 days after the hemorrhage[3] to within 48 to 60 hours after SAH.[9] In India the peripheral health centers provide primary care to patients with SAH, who are quite often diagnosed late or misdiagnosed. In our series, 24 patients were initially treated as `epileptics' and 62 as a case of `stroke' at the peripheral centers. This often led to a delay in referral, resulting in overall high mortality. Consequently, patients who reach a neurosurgi-

cal center do so around the end of the first week after ictus. In the present series, 121 patients arrived up to 14 days after the bleed. Nineteen of these came early enough to be operated upon within 3 days. From Table V it is apparent that worse the grade of patient after bleed, earlier is the presentation to our center. This is due to the referral pattern from our primary centers where an unconscious patient is referred faster than conscious patients. The later they were operated, better was the operative result. However, undue waiting could further worsen the overall management mortality. We had, therefore, consciously decided that a patient would be operated upon as and when he arrived, especially during the first 2 weeks, even if they arrived at the high risk time of vasospasm of 7 to 10 days[5] or had a poor grade. Solomon *et al* also reported operating on patients on arrival.[10] Despite our policy of early surgery, 8 patients died before surgery, 4 of whom re-bled.

While several centers in India are operating on a large number of aneurysm patients, yet there is a reluctance in operat-

Table VII: Glasgow outcome score at more than 6 months

Grade at Surgery	Glasgow outcome score grade				
	n*	V	III	II	Dead
I	26	26-(100.0)			
II	34	34-(100.0)			
III	14	13-(092.9)	1-(7.1)		
IV	20	14-(070.0)	1-(5.0)	4 - (20.0)	1-(5.0)
V	7	7-(100.0)			
TOTAL	101	94-(093.1)	2-(2.0)	4 - (4.0)	1-(1.0)

* 41 Patients lost to follow up and 29 patients dead at discharge. Figures in parentheses indicate percentage

ing upon poor grade patients.[6,11] In Sambasivan's series, 112 of 755 patients in poor grade were sent home.[6] Rout *et al* reported operative results in 115 patients, in whom only 6 were in grade III and IV and none in grade V.[11]

In the present series, 69 patients were in Hunt and Hess grade IV and V before surgery.

Timing of surgery and neurological grade

Maximum mortality was observed in patients operated on or before day 3 post SAH, i.e. (36.8%) progressively reducing to 6.3% at 11-14th day interval (table IV). This could be on account of the poor grade patients being referred to us. 59% of patients were in grade IV and V in the less than 11 day post SAH interval compared to only 25% in beyond this interval. We encountered a swollen brain in patients operated upon within 3 days of SAH but this could be managed with intraoperative ventricular drainage, hyperventilation and dehydrants[12,13] and did not lead to any significant increase in contusion or retraction injury to the brain. The presence of subarachnoid blood, in our experience, facilitated cisternal dissection as the blood had already enlarged these natural spaces.

In 1990, Winn *et al* reported their results on 79 patients undergoing early surgery in grade III, IV and V. Their mortality at 6 months of 13%, 35% and 41% respectively is similar to our mortality of 16.7% , 22.7% and 40%.[14] Auer reported that 86% of their patients operated upon in grade III and IV were living independently.[15] Suzuki reported that 50% of grade IV patients operated on within 3 days of SAH were leading independent lives.[16] The cooperative series reported a mortality of 22 % to 31% in drowsy patients (grade III), 39% to 46% in stuporous patients, and 32% to 79% in comatose patients.[5] Sambasivan reported a mortality rates of 24% and 62.5% in grade IV and V patients respectively.[10] In our series, presuming that all the patients lost to follow-up had the worst outcome, yet 21 out of 69(30.4%) patients in preoperative grade IV and V (7 of 25) had returned to normal life style. Other studies have also reported similar encouraging results.[17,18] The importance of neurological grade in patient selection is apparent even now, as several neurosurgeons will delay surgery in poor grade (IV and V) patients.[19] Recent reviews of this topic include authors who still do not advocate early surgery for poor grade patients, especially those in grade V.[20,21]

Influence of vasospasm

Diffuse vasospasm was present in 25.7% between 0-3 days, 28.1% between 4 to 6 days, in 38.9% between 7 to 10 days,

25.0% between 11 to 14 days post SAH in the present series. It does not seem to have translated into a higher mortality in this group of patients. In contrast to the cooperative data[5], our mortality was less (13.9%) in the 36 patients operated in the 7-10 day post SAH interval compared to patients operated prior to day 7 post SAH. It was least (6.3%) in 11-14 days interval. A confounding factor could be the large number of poor grade patients being referred to us in the first week and better grade patients reaching during the second week. The mortality rose steadily with increasing Fisher's grade on CT scan (Table II) which is similar to other published reports.[5,8]

It appears that mortality in the present study rises with vasospasm, as mortality rose from 14% to 21.6% in patients with focal and diffuse spasm respectively. However, if vasospasm is correlated with the neurological grade (Table VI), it can be seen that vasospasm has had no significant influence in patients outcome that were conscious and alert (grade II). In grade III, IV and V the incidence of vasospasm was high i.e.36%, 61.3% and 88% respectively. This increase in the occurrence of vasospasm in these drowsy or unconscious patients did not seem to have translated into higher mortality. Though the absence of vasospasm in poor grade patients was low, the mortality in this subgroup was high with 30% of patients in grade IV and 100% of patients in grade V without vasospasm.

It seems that concomitant presence of vasospasm in grade III, IV and V patient might indicate a possible reversible cause of the poor neurological status while poor neurological status in the absence of vasospasm may indicate an irreversible or more extensive primary insult. This hypothesis will require additional investigations to confirm.

Conclusion

Surgery on ruptured cerebral aneurysms as and when the patients arrive is a technically safe procedure. Neurological grade seems to correlate most with prognosis rather than vasospasm. No definite recommendation can be made about timing of surgery except that with the advent of strategies to combat vasospasm it appears safe to operate during 7 to 10 days post SAH interval. It is also possible that vasospasm in poor neurological grade may actually be a better prognostic feature compared to absence of vasospasm.

Limitations and Suggestions:

1. Evaluation for vasospasm in this study is based on a single preoperative angiogram. Diagnosis of DIND too is debatable. Though angiogram is the gold standard, transcranial

Doppler with or without CT angiogram can be utilized for serial follow up in the postoperative period.

2. The number of patients in this study especially in poor grade is relatively small. Testing of the present hypothesis is underway in a larger group of patients (of more than thousand patients).

Certification from authors

We certify that all the authors have contributed substantially to qualify as authors. We have no potential conflicts of interest and have taken no financial support for our work.

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