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# Use of Per-Operative Angiogram and Doppler Ultrasound as an Adjunct to Assess the Cerebral Vessels Following Aneurysmal Brain Surgery

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## ABSTRACT

***Objective:*** To study the efficacy of per-operative angiogram and Doppler ultrasound as an adjunct to assess the cerebral vessels during intracranial aneurysm clipping surgery.

***Study Design:*** Cross-sectional study

***Place and Duration of Study:*** Department of Neurosurgery, Combined Military Hospital, Rawalpindi Pakistan, from Jan 2020 to Dec 2021.

***Methodology:*** Forty-eight diagnosed cases of subarachnoid haemorrhage secondary to ruptured aneurysm were included. All the patients who were not coiled-able (broad-based, multi-lobed, complex) were operated on (craniotomy and clipping of aneurysm). Intraoperative angiogram and Doppler ultrasound of cerebral vasculature were done in all cases to see the patency of vessels and the position of clips.

***Results:*** Mean age of the patients was 43.97±8.23 years. 24(50.00%) patients had anterior communicating artery aneurysms, 18(37.50%) had middle cerebral artery aneurysms, whereas 6(12.50%) were of an anterior cerebral artery. Craniotomy and clipping of aneurysm were done in all the cases; among them, 15(31.25%) were operated on early (between 48-96 hrs), whereas 33(68.75%) were operated on after 10-14 days. Per-operatively, cerebral angiogram and Doppler ultrasound were used to assess the cerebral vasculature and position of the clip. About of 5(10.00%) required clip readjustment, 4(8.33%) had parent vessel occlusion, 10(20.83%) required vasodilator therapy due to vasospasm, and 4(8.33%) had residual aneurysm neck. All these were rectified during the same procedure.

***Conclusion:*** Per-operative angiography and Doppler ultrasound are useful adjuncts in aneurysmal brain surgery to prevent complications like cerebral ischemia, recurrence, residual aneurysm and re-bleed.

**Keywords:** Aneurysm, Cerebral angiogram, Ultrasonography doppler.

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## INTRODUCTION

Subarachnoid haemorrhage is a common neurosurgical emergency, with 14-19 per 100,000 cases yearly. It has a slight female predominance (male-female ratio of 2:3) and is more common in the black population.[1,2] Trauma is the most common cause of SAH, whereas ruptured aneurysm is the most common non-traumatic cause. Aneurysms are more common in cerebral vasculature as they lack external elastic lamina and have thin adventitia.[3] Moreover, cerebral vessels are lying unsupported in the arachnoid space, and the chances of rupture are directly proportional to the size of the aneurysm. However, a greater proportion of smaller aneurysms tend to bleed as well.[4] A CT scan of the brain reveals subarachnoid haemorrhage in different cisterns of the brain, and the CTA brain depicts a cerebral aneurysm.[5] Digital subtraction angiography is nowadays the gold standard investigation of choice as it is diagnostic and therapeutic (coiling can be done).[6] The aim of treatment in managing aneurysm is to recover from primary insult and treat and prevent complications.[7] Endovascular coiling is minimally invasive and is beneficial in patients with narrow neck aneurysms, old age and multiple co-morbidities.[8] Surgical clipping is beneficial in young age, wide neck and complex/lobulated aneurysms. During aneurysmal clipping, the neck of the aneurysm is occluded to prevent re-bleeding and maintain adequate cerebral blood flow. The correct position of the clip is the most important step, as recurrence, re-bleed, proximal and distal vessel occlusion, and cerebral ischemia can occur due to clip malposition.[9] Direct inspection of cerebral vasculature during surgery is routinely done to check the clip position. Moreover, Doppler ultrasound and per-operative angiogram are additional adjuncts to

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confirm this. They confirm the blood flow in all the vessels and ensure the perfect application of clips and occlusion of the aneurysm.[10] This study aims to determine the benefits of a per-operative angiogram and Doppler ultrasound as an adjunct to assess the cerebral vessels following aneurysmal brain surgery.

## METHODOLOGY

The cross-sectional study was conducted at the Department of Neurosurgery, Combined Military Hospital, Rawalpindi Pakistan, from January 2020 to December 2021 after permission from the Hospital Ethical Committee was obtained. The sample size was calculated using the WHO sample size calculator, taking the reported prevalence of aneurysmal SAH 6.8%.[10]

**Inclusion Criteria**: Patients of either gender, aged 20-years and having no history of any other neuro-logical disease, admitted with subarachnoid haemor-rhage secondary to broad-based, multi-lobed, complex cerebral aneurysm were included in the study.

**Exclusion criteria**: Patients who were previously operated and had recurrence of aneurysmal rupture, patients having chronic diseases like chronic renal failure, bleeding disorders, immuno-compromised, pregnant women and patients with coilable aneurysm (narrow neck, small, simple) were not included in the study.

Non-probability consecutive sampling technique was used to enrol the patients in the study. Written informed consent was taken from all patients included in the study. Hospital registration number, name, age, gender, address and phone number (optional) were noted, and this information was kept confidential under lock and key with the principal investigator. All the patients underwent CTA brain and DSA to localise the aneurysm, followed by clipping of the aneurysm through a personal approach. Per-operatively, just after the clip application and visual inspection of vessels, a Doppler ultrasound probe was used to confirm blood flow in all adjacent vessels by assessing the waveform. Moreover, just after clip application during procedure four, vessel digital subtraction angiography was done in all the patients to see the patency of all the vasculature, analyse the position of the clip and perform vasodilation therapy (if required). During DSA, the femoral artery was cannulated under ultrasound guidance, and the 5F femoral sheath was passed. Then, the glide wire was advanced under an image intensifier, followed by vertebral catheter advancement over the glide wire. Four-vessel DSA was done with the help of ultravist contrast. If cerebral vessels were found in spasm, then injection verapamil was injected intra-arterially as a vasodilator therapy.

Statistical Package for Social Sciences (SPSS) version 25.0 was used for the data analysis. Quantitative variables were expressed as Mean±SD and qualitative variables were expressed as frequency and percentages

## RESULTS

Forty-eight patients with subarachnoid haemorrhage secondary to rupture of cerebral aneurysm were recruited for this study. The mean age of patients was 43.97±8.23 years ranging from 28-80 years. Among 48 patients, 24 (50.00%) patients had anterior communicating artery aneurysms, 18(37.50%) had middle cerebral artery aneurysms, whereas 6(12.50%) were of an anterior cerebral artery. Craniotomy and clipping of aneurysm were done in all the cases; among them, 15(31.25%) were operated early (between 48-96 hours), whereas 33(68.75%) were operated after 10-14 days, i.e. late. Per-operatively, cerebral angiogram and Doppler ultrasound were used to assess the cerebral vasculature and position of the clip 5(10.00%) required clip readjustment, 4(8.33%) had parent vessel occlusion, 10(20.83%) required vasodilator therapy due to vasospasm, and 4(8.33%) had residual aneurysm neck (Table). All the patients remained alive, and there was no change in neurological deficit per pre-operatively.

**Table: Assessment of Cerebral Vasculature (n=48)**

| Parameters | Clip Readjustment required | Parent vessel occlusion | Requirement of vasodilator therapy | Residual aneurysmal neck |
|---|---|---|---|---|
| Total | 5(10.00%) | 4(8.33%) | 10(20.83%) | 4(8.33%) |
| Per-op Angiogram | 3(10.71%) | 3(10.71%) | 6(21.42%) | 1(3.57%) |
| Doppler Ultrasound | 2(10.00%) | 1(5.00%) | 4(20.00%) | 3(15.00%) |

## DISCUSSION

Subarachnoid haemorrhage secondary to aneurysmal bleeding is a neurosurgical emergency that requires prompt diagnosis and treatment to save precious lives. Patients generally present with sudden onset headache, loss of consciousness, fits, vomiting or weakness of any body part.[11,12] Urgent CT scan of the brain reveals SAH. There are multiple grading systems to assess the severity, like WFNS, Hunt-Huss grading

system and Modified Fisher Scale. They all indicate that the higher the grade, the poorer the prognosis.[13] CTA brain and DSA are done to localise the aneurysm and plan the treatment accordingly. Endovascular coiling of aneurysm is the gold standard treatment in narrow neck aneurysms, patients with multiple co-morbidities and old age.[14] However, young adults with wide necks complex and lobulated aneurysms require clipping. Lower incidence of re-bleed, reduced mortality and less frequency of treatment failure make clipping a superior procedure over coiling.[15]

Timing of clipping is very important as it has to be done within 48-96hrs (early) or after 10-14 days (late) as vasospasm is highest from day 5th to 10th post SAH.[16] Advantages of early surgery include elimination of risk of re-bleed, facilitation of treatment of vasospasm by volume expansion, lavage of vasospasmogenic agents and use of thrombolytic drugs whereas marked oedema and inflammation during early phase render brain more susceptible to injury, presence of solid clots that impede surgery, high risk of intra-operative rupture and vasospasm due to mechano-trauma during surgery are few disadvantages of early procedure.[17] Young individuals with good neurological status (H & H grade <3), the large amount of SAH increasing the likelihood of early vasospasm, patients having uncontrolled HTN and seizures, large clots causing mass effect and early re-bleed favour early clipping.[18] Old age, poor medical condition, poor neurological status (H & H grade > 4), large aneurysms, significant brain oedema and active vasospasm advocate late aneurysm clipping. Challenging aneurysms of size >7 mm and neck width >4 mm were significantly associated with a higher incidence of suboptimal aneurysmal clipping.[19] In our study, 10% of patients required clip readjustment after angiographic and Doppler evaluation. The most important complications post-operatively include cerebral vasospasm, delayed ischemic neurological deficit (DIND), re-bleeding, seizures and hyponatremia. In order to prevent vasospasm and DIND, cerebral angiogram and Doppler ultrasound are used as adjuncts during the procedure.[20] In our study, 5(10%) patients required clip readjustment, 4(8.33%) had parent vessel occlusion, 10(20.83%) required vasodilator therapy due to vasospasm and 4(8.33%) had residual aneurysm neck. Thus making these adjuncts an important part of the procedure in order to prevent dreadful complications.

## LIMITATION OF STUDY

This study has been conducted at a single centre with a limited number of patients, so the results must be generalised to only some of the population. A multi-centric and multi-ethnic study must be conducted for more comprehensive statistical analysis.

## CONCLUSION

Clipping for aneurysmal bleed is a common neurosurgical procedure; per-operative angiography and Doppler ultrasound are useful adjuncts in aneurysmal brain surgery to prevent complications like cerebral ischemia, recurrence, residual aneurysm and re-bleed.

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**Author's Contribution**

Following authors have made substantial contributions to the manuscript as under:

AAK & HUK: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

KAB & SAQ: Data acquisition, data analysis, critical review, approval of the final version to be published.

SAA & AH & BS: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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