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EVALUATION OF EARLY AND DELAYED INFARCTS FOLLOWING CLIPPING OF RUPTURED INTRACRANIAL ANEURYSM : IMPACT ON SHORT AND MEDIUM TERM OUTCOME ASSESSED WITH DIFFUSION-WEIGHTED MRI

Neurosurgery

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ABSTRACT

Temporary vascular occlusion is utilized in aneurysm surgeries to lower the risk of intraoperative hemorrhage and associated ischemia. Several studies have examined the permissible time of occlusion of the parent artery using temporary clip during aneurysm surgeries. However, the incidence of silent ischemic events in patients with aneurysms treated with microsurgical clipping has not been studied extensively. Therefore, in this study, we examined the association between various parameters of temporary clipping and incidence of clinically silent vs symptomatic infarction. Post-operative diffusion weighted MRI changes were used to diagnose silent infarcts. We found a statistically significant association between the maximum time of single clip application and ischemia. We conclude that intermittent multiple temporary clippings instead of a single clip application of longer duration may reduce incidence of clinically silent post-clipping infarcts .

KEYWORDS

Intracranial aneurysm, Cerebral infarcts, Diffusion weighted MRI, Temporary clip

INTRODUCTION

Temporary vessel occlusion enables a surgeon to dissect aneurysms and clip them with a lower risk of intraoperative hemorrhage and associated infarction. The infarction may manifest or may be silent. Several studies have assessed the permissible time of occlusion of parent artery using temporary clip; however, the incidence of silent infaction events in patients with aneurysms treated with microsurgical clipping is not well documented. These infarcts do not manifest clinically, however they may be detected by various means such as positron emission tomography scans, single photon emission computed tomography scan, or various sequences of magnetic resonance imaging (MRI). In this study we analyzed the risk of symptomatic and silent infarcts in association with temporary microsurgical clipping of intracranial aneurysms using diffusion-weighted magnetic resonance imaging (DWMRI) and evaluated clipping time associated with silent infarcts. We used DWMRI in our study due to its wide availability, feasibility, and cost effectiveness .

MATERIALS AND METHODS

We analyzed the surgical outcomes of World Federation of Neurological Surgeons (WFNS) grades I to III patients undergoing craniotomy and clipping of anterior circulation cerebral aneurysms by a single surgeon over a 3 year period . Standard anesthetic protocol was administered for aneurysm clipping. We recorded the the number and the time for which temporary clips were applied. Other possible causes for infarction were ruled out. DWMRI brain was performed prior to and within 24 hours of surgery in all patients. An experienced neuroradiologist evaluated the images for signs of infarction. These were then correlated with patient's post clipping neurological status and categorized as asymptomatic or symptomatic

STATISTICAL ANALYSIS

Baseline demographics of the study population were analyzed using descriptive statistical parameters. Fischer's exact test or chi-square tests were used for comparison of categorical variables. Rank-sum or equivalent Mann–Whitney U test were used for comparisons of continuous variables. For all analyses, $p < 0.05$ was considered statistically significant. All computations were performed using the commercially available software programs and with an statistician's aid.

RESULTS

A total of 50 patients 29 males (58%) and 21 (42%) females were evaluated. 40 were in the WFNS grade I, 6 in grade II, and 4 in grade III. There were 18 patients with WFNS grade I diagnosis in 31 to 40 years age group, followed by 12 patients in grade I, two in grade II, and one in grade III in 41 to 50 year age group. The mean age of presentation was 40.32 years. Headache was the most common presenting symptom in all patients followed by vomiting and loss of consciousness. Hemiparesis was reported in 4 patients.

27 (54%) patients had an anterior communicating artery aneurysm, 16 (32%) had middle cerebral artery (MCA) aneurysms, 4 (8%) had a supraclinoid internal carotid artery (ICA) aneurysms, and 3 (6%) had an aneurysms at the junction of ICA–posterior communicating artery.

Out of 50 patients, infarction associated changes were noted on imaging in 13 (26%) patients on immediate postoperative DWMRI study. Subgroup analysis by size of the aneurysm revealed only 1(8.33%) case of infarct amongst 12 patients with small (<7 mm)aneurysm. 30 patients had a medium (7–14 mm) size aneurysm of which 6 (20%) developed infarct. 4 (66.66%) out of 6 patients with large aneurysms (15–24 mm) developed infarct (Table 1).

Table 1. Aneurysm size vs. postoperative infarction DWMR. The table shows occurrence of infarct in different groups according to the size of aneurysms.

Size of aneurysm	Symptomatic infarct cases	Asymptomatic infarct cases	Noninfarct cases	Total
Small (<7 mm)	0	1(8.33%)	11(91.66%)	12
Medium (7–14 mm)	4(13.33%)	2(6.66%)	24(80%)	30
Large (15–24 mm)	2(33.33%)	2(33.33%)	2(33.33%)	6
Giant (≥25 mm)	0	2(100%)	0	2
Total	6(12%)	7(14%)	37(74%)	50

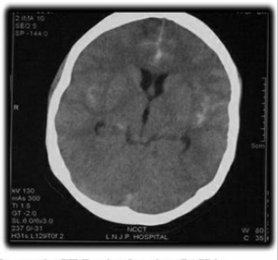

Image 1: CT Brain showing SAH in Interhemipheric and B/L Sylvian fissure.

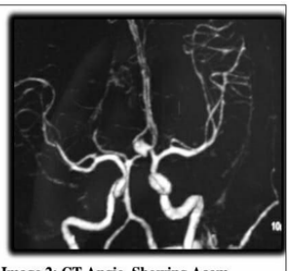

Image 2: CT Angio. Showing Acom Artery Aneurysm.

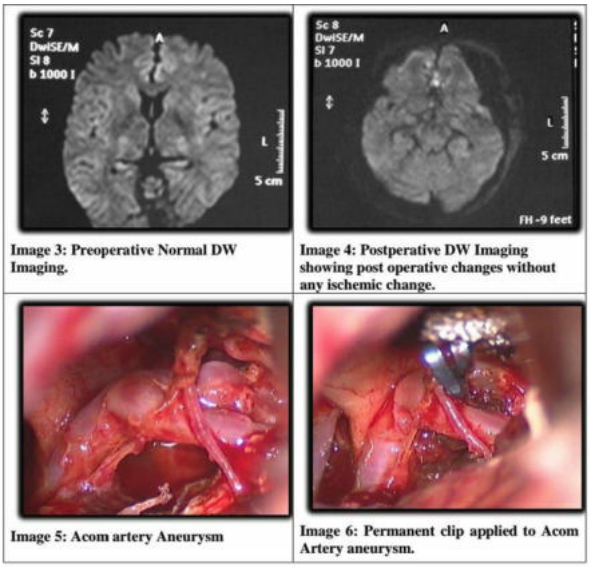

Image 3: Preoperative Normal DW Imaging.

Image 4: Postperative DW Imaging showing post operative changes without any ischemic change.

Image 5: Acom artery Aneurysm

Image 6: Permanent clip applied to Acom Artery aneurysm.

Fig. 1: Asymptomatic infarct after temporary clipping of a case of ACom Aneurysm

In 39 (78%) cases, temporary clip was applied, out of which 6 (15.38%) and 7(17.94%) patients developed symptomatic and asymptomatic infarcts, respectively (Figs. 1 and 2). No infarction related changes were noted in 11 patients in whom temporary clip was not used.

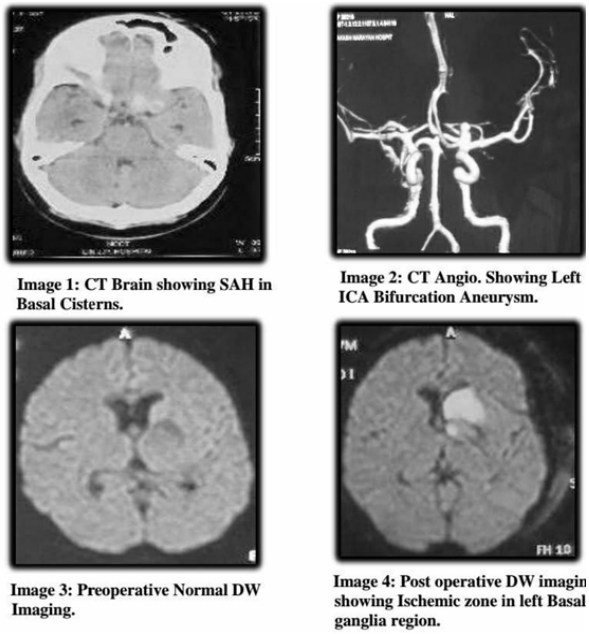

Image 1: CT Brain showing SAH in Basal Cisterns.

Image 2: CT Angio. Showing Left ICA Bifurcation Aneurysm.

Image 3: Preoperative Normal DW Imaging.

Image 4: Post operative DW imagin showing Ischemic zone in left Basal ganglia region.

Fig 2: Showing Symptomatic infarct after temporary clipping in a case of left MCA Aneurysm

The average total mean time of temporary clip application, leading to symptomatic as well as DWMRI-proved infarct cases, was 301.28 seconds. In asymptomatic, DWMRI proven infarct cases, the mean occlusion time was 124.56 seconds. patients with no infarction on post-op DWMRI images had a mean occlusion of 126.71 seconds.

Maximum time for continuous temporary clip application was 145.78 seconds in symptomatic and 144.89 asymptomatic post clipping infaction cases. In patients without any post clipping infarction changes, the maximum continuous use of temporary clip was only 82.09 seconds.

The average number of vessels temporary clipped in each infarct category were: 3.48 in cases of symptomatic infarct, 2.38 in asymptomatic infarct group and 1.58 clips in patient without any post clipping infarct on DWMRI (Fig. 1).

Glasgow outcome scale at 1 month from discharge was scored 4 in post clipping symptomatic infarct cases and5 in both asymptomatic infarct cases and in patients without infarction. Out of 50 patients, 12% patients developed a symptomatic infarctand ,14% developed an asymptomatic infarct as assessed with DWMRI.

DISCUSSION

Patients with aneurysmal subarachnoid hemorrhage (SAH) who develop a cerebral infarction are less likely to make a good recovery and more likely to die or survive with deficit than those without infarction.[1] Similalrly, in the present study we found that Glasgow outcome scale at the time of discharge was significantly worst in post clipping infarction group compared with the non-infarct group.

Juvela et al[2] have reported a 65% incidence of infarcts on postoperative CT scan in patients with aSAH. Krayenbühl et al[3] reported the incidence of symptomatic and asymptomatic infarcts to be 2 and 9.5%, respectively following microsurgical clipping of intracranial aneurysms. Similarly, Ferch et al[4] also found a 17% incidence of symptomatic and 26% incidence of radiologically evident infarction after the use of temporary clip. In this study, symptomatic and asymptomatic infarction changes were observed in 12 and 14% patients, respectively as evidenced by DWMRI sequence. Overall, 33.33% of our study population developed infarction related radiologic changes when temporary clipping was used during surgeries, which is consistent with previous studies. Cronqvist et al[5] reported over all silent and symptomatic infarction rate of 23% using diffusion and perfusion MRI in patients with ruptured and unruptured intracranial aneurysms treated by endovascular coiling. This is comparable to our study result of 26% in post clipping group in spite of taking advantage of full anticoagulation in endovascular treatment.

Median age of patients in post clipping infarction group was 50,while it was 40 years in patients without infarct. However, univariate analysis suggested no significant statistical relation of age with post clipping infarction changes. There is no statistically significant difference between sex, size, and location of aneurysm between the group with and without post clipping infarction as reported previously.[3]

It has previously been suggested that the use of temporary clipping during microsurgery of aneurysms may lead to infarction events.[4,5] The duration of temporary clipping was found to correlate with increased occurrence of infarction events.[3,6] However, Selvapandian et al[7] found no statistically significant correlation between occurrence of complications and total duration or number of temporary clippings.In this study we noted that although use of multiple temporary clips was not associated with increased incidence of postoperative infarcts, however, single application of a clip for a longer period (single maximum time of temporary clip application, p-value = 0.01248) may influence the occurrence of both silent and symptomatic infarcts. We also found that one-time temporary clip application for less than 145 seconds may be associated with lower risk of symptomatic infarcts complication to happen. However, keeping the duration below 90 seconds may prevent early DWMRI infarction changes. The total time of temporary clip application was much shorter in our study as of 585.4 ± 858.4 seconds in contrast to other studies reported.[1] Although Ogilvy et al[8] suggested safe temporary clip application for up to 20 minutes, in this study the critical time period of temporary clip application is 5 minutes, that is, 300 seconds. However, to prove, this would require further intraoperative study such as Doppler and intraoperative video angiographies to assess changes in blood flow happening at the time of temporary clipping (Table 2). Lastly, similar to the report by Li et al.[9], larger aneurysms were associated with higher risk of infarction.

Table 2. Univariate analysis showing association of infarction with various factors.

Factors	Infarct group (*n* =13)	Noninfarct group (*n* =37)	*p*-Value
Age	50 ± 18	40 ± 9	0.4949
Male/Female (%)	5(38.46%)/8 (61.53%)	24(64.86%)/13 (35.13%)	0.1194
Location of aneurysm			0.1474
ACOM artery	6	21	
MCA	3	13	
ICA bifurcation	2	2	
ICA-PCOM	2	1	

Size			0.6539
Small	1	11	
Medium	6	24	
Large	4	2	
Giant	2	0	
Temporary clip used			0.5322
Yes	13	26	
No	0	11	
Number of times temporary clip used	3.48 ± 0.81	2.38 ± 0.64	0.0752
Single maximum time of temporary clip application (sec)	145	82.09	**0.01248 (<0.05)**
Total time of temporary clip application (sec)	242	126.71	**0.00815 (<0.05)**
Mean GOS at 1 month	4.07	4.68	0.2079
WFNS grade			0.1074
I	7	33	
II	4	2	
III	2	2	

Abbreviations:
ACOM, anterior communicating; GOS, Glasgow outcome scale; ICA, internal carotid artery; MCA, middle cerebral artery; PCOM, posterior communicating artery; WFNS, World Federation of Neurological Surgeons.

Note: For categorical variables—Fischer's exact or chi-square tests were used and for continuous variables, the rank-sum or equivalent Mann–Whitney U test was used. Significant p-value < 0.05 is mentioned in bold letters.

CONCLUSION

Maximum time of single clip application and total time of temporary clip application during aneurysm surgeries showed a significantl association with clinically silent infarcts. However, multiple uses of short duration temporary clipping did not shoe such an association. Therefore, intermittent multiple temporary clippings instead of a single clip application of longer duration may reduce incidence of clinically silent post-clipping infarcts. The incidence of infarcts occurring following temporary clip placement is is similar to that reported in endovascular treatment despite the fact that latter procedure benefits from anticoagulation at the time of intervention.

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Conflict of Interest: None.

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