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Experience, challenges and lessons learnt from microsurgical clipping of intracranial aneurysms at an emerging neurosurgical centre

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ABSTRACT

Objectives: To share our experience, challenges faced, lessons learnt and analyze the results of surgical management by microsurgical clipping of intracranial aneurysms at an emerging neurosurgical centre at Guru Gobind Singh medical college and hospital (GGSMC&H) Faridkot, Punjab. India.

Material and Methods: This study includes all the patients who presented with the diagnosis of intracranial aneurysm on CT angiography and were treated with the microsurgical clipping, between March 2017 to April 2019.

Results: There was a total of 23 patients 11f female and 12 male. Age range 32 to 85years. On admission 22 patients had SAH on CT scan and one was admitted after incidental detection of the aneurysm without SAH. The time interval between ictus and admission was 0-3 days in 13 patients, 3-14 days in 8 patients and more than 14 days in 1 patient. WFNS grade (gd) I-15 patients, gd II-2, gd III-2, gd IV-3 patients. Fisher gd I-nil, gd II-9, gd III-4, gd IV-9 patients. In 23 patients 27 Aneurysms were clipped. Distribution of location was Anterior Communicating-12, Distal Anterior Cerebral Artery- 4, Middle cerebral artery (MCA) Bifurcation-3, MCA trifurcation-1, Anterior Choroidal-1, Posterior Communicating (P-com) -1, Ophthalmic Internal Carotid Artery (OICA)-4 and three patients had associated multiple aneurysms. Size of aneurysms varied from < 02mm diameter in 2 patients, 2-25mm - 23 and, more than 25mm-2 aneurysms. There was intra op rupture in 2 cases. Post-operatively 2 patients developed hemiparesis, which recovered, nine patients developed vasospasm. Two patients developed chest related complications. One patient developed renal failure. There were 8 deaths. Patients are on follow up since March 2017 till date.

Conclusions: Intracranial aneurysms are challenging to manage due to their proximity to vital intracranial structures, and difficulty in securing intracranial proximal control. Thorough knowledge of intracranial anatomy of adjacent relations, arachnoid planes and skilful dissection is a key element for a successful outcome. Data collected from GGSMC & Hospital may not be representative of the entire state or country's population. Therefore, a large-scale data collection is necessary to create our own database to ascertain the risk factors and preventive measures that are exclusive to our state and nation.

INTRODUCTION

In simple words an aneurysm is an abnormal dilatation of an artery wall

Keywords
intracranial aneurysm, microsurgical clipping, pterional craniotomy, subarachnoid haemorrhage, vasospasm

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and in the brain commonly arises at branching points on a parent artery. Intracranial aneurysms (IAs) are usually revealed after they rupture, leading to subarachnoid hemorrhage (SAH). Usually the sentinel headache is the earliest warning sign of incipient rupture. Less frequently, they manifest themselves as a result of mass effect or are noticed incidentally during neuro-radiologic examinations performed for other diagnostic purposes.(6,9) Subarachnoid hemorrhage (SAH) due to the rupture of an intracranial aneurysm is a devastating event associated with high rates of mortality (40%–50%) and morbidity.(10, 20, 23, 13) The risk of intracranial aneurysm for human beings is 1 to 2% . (5)

The prime motive of intracranial aneurysm treatment is to exclude the aneurysm from the circulation; this can be achieved through two ways, microsurgical treatment or endovascular obliteration. Since ours is an emerging neurosurgical center where we have basic neurosurgical facilities, but lack digital subtraction angiography (DSA) and coiling facility. We are managing intracranial aneurysms with microsurgical clipping. The objective of this article is to share our experience acquired with the use of microsurgical obliteration of intracranial aneurysms at Guru Gobind Singh Medical College and Hospital Faridkot, Punjab, India.

Material and methods

This study includes all the patients admitted to the neurosurgery department who presented with diagnosis of intracranial aneurysm and were treated with the microsurgical clipping, in the period between March 2017 and April 2019. Patients who presented with poor neurological status, with fixed dilated pupils and who did not give consent for surgery were excluded.

On their arrival at the emergency department, all the patients were treated according to the defined protocol for the treatment of subarachnoid hemorrhage in the hospital and were admitted to Neurosurgical intensive care units and managed depending on their neurologic state at the moment of admission, determined by using GCS, the Word Federation of Neurologic Surgeons (WFNS) scale and fisher grades of SAH on non contrast computed tomography (NCCT) Scan of brain.

All the patients suspected with intra cranial aneurysm were subjected to cerebral CT angiography. Presence of aneurysm on CT angiogram was considered an essentiality to proceed for surgical treatment.

The aneurysmal sacs were labeled according to their number in single or multiple aneurysms, and distributed according to their location in the anterior segment or posterior segment of the circle of Willis', the projection and whether unilateral or bilateral. Outcome was evaluated using the modified Rankin scale (mRS). Patients are under follow-up since March 2017 till date.

Results

There were a total 23 patients out of which 11 (47.82%) were female and 12 (52.17%) were male. Age range was 32 to 85 years. At the time of admission 22 patients had SAH on CT scan and one patient was admitted after incidental detection of aneurysm without SAH. Time of admission from time of ictus 0-3 days in 13 (59.09%) patients, 3-14 days in 8(36.36%) patients and more than 14 days in 1(04.54%) patient. WFNS gd I-15(68.18%), gd II-2 (09.09%), gd III-2 (09.09%), gd IV-3(13.36%) patients. Fisher gd I-nil, gd II-9 (40.90%), gd III-4 (18.18%), gd IV-9 (40.90%) patients. There were 31 aneurysms in total out of which 27 were clipped in 23 patients. Location wise anterior Communicating Artery (A-Com)- 12 , Distal Anterior Cerebral Artery DACA- 4, middle cerebral artery (MCA) Bifurcation-3, MCA Trifurcation-1, Anterior Choroidal-1, Posterior communicating (Pcom)-1, Ophthalmic internal carotid artery (ICA)-4 and three patients had associated multiple aneurysms. Size of aneurysms varied from < 02mm diameter in 2 patients, 2-25mm in 23 and, more than 25m in 2 patients (Table 1).

Sixteen 69.5% patients had comorbidities out of which 11 (68.75%) hypertension, one (06.25%) Diabetes, one (06.25%) Asthma, one (06.25%) had Chronic liver disease and in 1 patient (06.25%) Chronic kidney disease was diagnosed post operatively. There was intra op rupture in 2 (07.07%) cases. Post operatively 2 (8.69%) patients developed hemiparesis, which recovered over a period of time, nine (39.13%) patients developed vasospasm after surgery. Two (08.69%) patients developed chest related complications. In the study there were 8(34.78%) deaths. Follow up has ranged since March 2017 to till date.

Variable		No	%
Aneurysm Number	Single	18	78.26
	Multiple	5	21.73
Aneurysm side	Unilateral	21	91.30
	Bilateral	2	08.70
Size of the sac	<2mm	2	7.40
	2-25 mm	23	85.18
	>25 mm	2	7.40
Morphology of the sac	Secular	21	77.77
	Fusiform	NIL	0
	Multilobulated	6	22.23
Condition of the Sac	Ruptured	22	81.48
	Unruptured	5	18.52
A com aneurysms		12	44.44
	Superiorly projecting	4	33.33
	Anteriorly projecting	2	16.66
	Antero-superior	1	08.33
	Inferior	3	25
	Antero-Inferior	2	16.66
DACA aneurysms		4	14.81
	anterior	1	25
	Anterior superior	2	50
	Anterior toward opp side	1	25
	superior	Nil	0
MCA bifurcation Aneurysm		3	11.11
MCA trifurcation Aneurysms		1	03.70
Anterior choroidal Aneurysm		1	03.70
Ophthalmic seg Aneurysm		4	14.81
Communicating segment aneurysm		1	03.70
P-com Aneurysm		1	03.70

Discussion

Intracranial aneurysms (IAs) are localized dilations of the cerebral arteries wall and are prone to rupture, resulting in bleeding. The overall prevalence of unruptured IAs is between 2% and 3.2% in the general population with a male to female ratio of 1:2.(19) Ruptured aneurysm is responsible for 85% of SAH which is one of the leading causes of haemorrhagic stroke. (18)

Junjie Zhao et al have described 4 Basic Types of intra cranial aneurysms (IAs).(25) (A)- Secular are the most common type of IAs. They resemble a round out pouching with well-defined aneurysmal domes and necks connecting to the parent vessel. Commonly they occur at bifurcation locations e.g. between the MCA and the posterior cerebral artery (PCA), between the anterior cerebral artery (ACA) and the anterior communicating artery (A Com) and between the bifurcations of MCA branches. (4) (B)- Micro aneurysms are IAs with diameters smaller than 2 mm.(11) (C)-Giant IAs are with diameters over 25 mm. The latter account for merely 5% of all IAs, but their prognosis is relatively dismal. (7, 17) Untreated giant IAs have over 50% risk in rupturing and 88% to 100% in mortality at 2-year follow-up. (2,12) We encountered two giant aneurysms. Due to their large size the mass effect alone can cause intracranial hypertension and neurological dysfunctions one of our patient with giant aneurysm presented with decreasing vision. (D)-Fusiform IA is widened and thinning segment of artery. According to Yahia et al, this dilatation must affect at least 270° of the lumen's circumference to be classified as fusiform.(24) Their surgical treatment is challenging due to the vital perforators located within the affected segment. We did not encounter any fusiform aneurysm.

In our Study the majority of patients were from the state of Punjab, (52.17%) male and (47.82%) female. A study conducted by Ab Ghani et al showed the mean age of affected patients as 48.9 years old, with 56.7% males and 43.3 % females.(1) A study by Rinkel et al., suggests that the incidence of intracranial aneurysm increases with age, and the most of the cases occur among patients in fifth decade of their life. (15) In our study the mean age of the patient was 50.3years. Male patients were more frequent than females, which is in contrast to the usual pattern of females being affected more than males. (16) However, this ratio does not seem to be applicable in all populations and may vary from state to state and country to country. (8)

In our study 69.5% patients had comorbidities out of which 68.75% hypertension, 06.25% Diabetes, 06.25% Asthma, 06.25% had Chronic liver disease and in 1 patient (06.25%) Chronic kidney disease was diagnosed post operatively. In the study population of Ab Ghani et al, 85.7% had hypertension. (1) Variation of blood pressure and hypertension are known risk factors for the development of intracranial aneurysm. (21)

Intracranial arteries are comprised of the outer layer of the adventitia, a muscular media that maintains most of the vessel wall integrity and the inner layer of intima. As compare to other vessels in the body they do not have external elastic lamina, which is located between the adventitia and media leading to less elasticity of the media. They also have thinner adventitia compared to the extra cranial artery wall. These vessels exist in the subarachnoid space, which lack surrounding connective tissue to support the vessels. (1) These features predispose intracranial arteries to the formation of saccular aneurysms, commonly in hypertensive patients as the thin and less elastic vessel wall is subject to increased pressures, as well as in patients with congenital conditions which predispose to defects in the muscular layer of the arterial wall, such as autosomal dominant polycystic kidney disease, Ehler- Danlos syndrome fibromuscular dysplasia, and Marfan syndrome. (1, 15, 3)

Patients without history of hypertension in our study but having hypertension on presentation might have been undiagnosed with hypertension previously or it could be due to raised ICP. Common history among our patients was that they rarely go to the physician for routine checkup and those who do so, many of them had history of poor compliance of antihypertensive medication and no regular follow up. These facts accentuate the importance of hypertension screening and control.

Among the 23 patients who underwent microsurgical clipping, the majority were Fisher II, III or Fisher IV indicating that most patients only presented post intracranial aneurysm rupture with an added risk of vasospasm. It also reflects that incidental finding of intracranial aneurysm is still rare despite the improvement of our health services and increasing amount of imaging being done for other neurologic symptoms.

Post operatively two patients developed hemiparesis, which recovered, one patients developed chest related complication because of underlying bronchial asthma despite an improvement in GCS. However, based on the outcome in our observational study , within a span of three months after surgery, 8 (34.78%) had the mRS score of 0 with no symptoms at all, and 8 (34.78%) had the mRS score of 6 or had died. The cause of

death was post operative vasospasm in 4 (50%) patients. One (12.5%) of them had anaemia secondary to upper gastrointestinal bleed due to stress ulcer which was diagnosed on upper GI endoscopy. Postoperative chest infection in one (12.5%), chronic renal failure in one (12.5%) and pulmonary embolism in one (12.5%) patient. Literature says maximum risk of vasospasm is 3-14 days of ictus.(22,14) Three of our patients who died, developed vasospasm in first two weeks after ictus. After three months of discharge, four patients with mRS scores of 1 and 2 improved to the mRS score of 0, and after 6 months of discharge total 12 (52.17%) patient improve to MRS score 0. Others three are still on rehabilitation. This improvement was mainly due to the after care of patients, which comprises intensive rehabilitation and physiotherapy.

Our interesting cases

Giant Aneurysm

Case 1: 45 year old female presented with right basal ganglia bleed CT angio revealed giant multi lobulated ophthalmic segment aneurysm. Patient underwent right pterional craniotomy with right neck control for proximal ICA. Because of its large size proximal and distal ICA was not visible. So, aneurysmal sac was punctured, with controlled suction aneurysmal sac was deflated that led to visualization of proximal, distal ICA and neck of the aneurysm, as a result we were able to apply permanent clip over the neck of the aneurysm. Post operatively patient was discharged without any deficit. Figure 1.

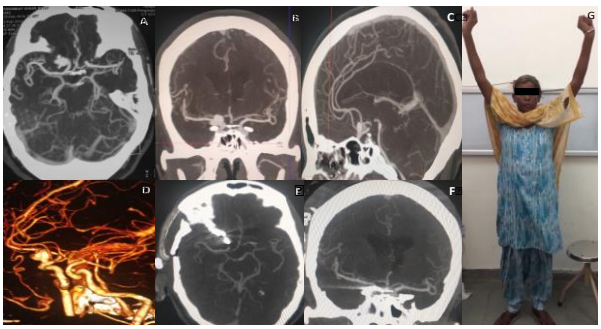

Figure 1. Computed tomography angiography of right ophthalmic aneurysm, axial view (A) showing multilobulated large aneurysm. Coronal view (B) showing the superiorly projecting aneurysm. Sagittal view (C) aneurysm with narrow neck. Three dimensional CT (D) showing large superiorly projecting ophthalmic aneurysms. Post op Computed tomography angiography (E and F) complete occlusion of aneurysm. (G) Patient is fine with no deficit.

Multiple Aneurysms

Case 2: 32 years old male patient presented with left anterior choroidal artery aneurysm and right MCA Bifurcation aneurysm. It was a challenge to manage both side aneurysms in a single surgery. We planed for two stage surgery based on SAH picture on NCCT brain and CT angio findings, we first clipped left anterior choroidal artery aneurysm. After dissection of the aneurysm the surgeon got engaged in selecting appropriate clip for few seconds, surgical field was out of his sight, aneurysm got ruptured and visible anatomy got distorted that led to difficult management of the ruptured aneurysm. The learning point for us was, if possible never let the aneurysm out of your vision after aneurysmal neck dissection from its surroundings and try to select the appropriate clip prior to final dissection. We clipped right MCA bifurcation aneurysm second stage successfully and patient was discharged with no deficit.

Case 3: 45 years male patient was presented with right MCA aneurysm and ophthalmic segment bleb. MCA aneurysm was clipped first and we faced difficulty in clip application over bleb, the clip slipped multiple times over bleb. We realized that we had limited number of small aneurysmal clips. Although In a small center like ours there are limited resources, surgeon should try to have back up of all sizes and shapes of clips before surgery. Figure 2.

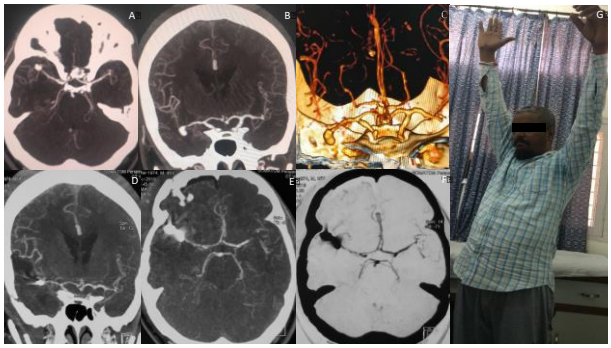

Figure 2. Computed tomography angiography of patient with multiple intracranial aneurysm (right middle cerebral artery bifurcation and right ophthalmic aneurysm), axial view (A) showing laterally projecting aneurysm right middle cerebral artery bifurcation aneurysm. Coronal view (B) and Three dimensional CT (C) showing the inferiorly projecting right MCA bifurcation and medially projecting right ophthalmic aneurysm. Post op Computed tomography angiography, coronal view (D), axial(F and G) showing complete occlusion of both aneurysms. (G) Patient is fine with no deficit.

Case 4: A 65 years old female patient was presented with left pcom (Bled), left ophthalmic segment, A-com and right MCA bifurcation aneurysm. All left sided aneurysms were clipped in the first surgery. Right MCA bifurcation Aneurysm was planned for second stage elective surgery but patient developed thrombocytopenia and surgery was deferred. Figure 3 A&B. Patient is asymptomatic and on regular follow up and is being worked up for intractable thrombocytopenia.

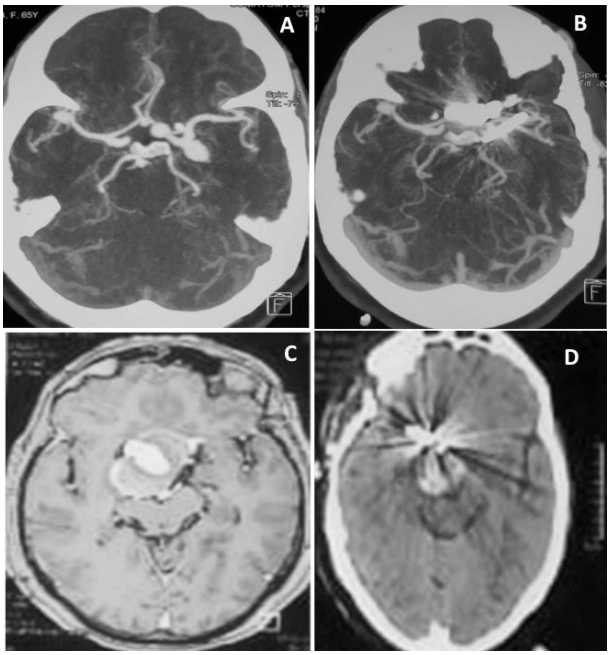

Figure 3. Axial view (A) showing the laterally projecting left PCOM , medially projecting left ophthalmic segment, ACOM and laterally projecting right MCA bifurcation aneurysm and (B) Post op Computed tomography angiography left PCOM,left ophthalmic segment and ACOM aneurysms T1 contrast MRI axial view (C) showing gaint atherosclerotic right communicating segment aneurysm and non-contrast computed tomography, Axial view (D) showing post op clip artefact with occlusion of neck.

Missed aneurysm

Case 5: A 52 years old male patient was presented with SAH in left sylvian fissure and inter hemispheric fissure CT angiogram suggested left DACA aneurysm. In view of SAH location the aneurysm was approached through left inter hemispheric approach but we could not find aneurysm on the left side. We found aneurysm on right DACA after cutting the falx. Aneurysm was clipped and patient remained stable for one week and was planned for discharge but the night before discharge patient had a sudden fall in GCS, immediate NCCT with CT angio Head was done, it showed diffuse SAH and Suggested right MCA aneurysm which was not visualized on the first CT Angiogram. We learnt that when ever there is discrepancy in the location of the aneurysm and the location of SAH on CT Angiogram, DSA should be done. Unfortunately, in our setup DSA facility is not available.

Aneurysms, which required ICA ligation.

Case 6: A 35 years old male patient was presented with left ophthalmic segment aneurysm, neck control was taken before starting surgery, during dissection of sylvian fissure aneurysm neck got avulsed probably due to traction during sylvian fissure dissection and brain started bulging, and patient became hypotensive. We could not control the bleeding with neck control, urgent left temporal and frontal lobe were removed and ICA just proximal to its bifurcation was clipped, I our opinion that was the best possible thing we could do in such a condition. Post op patient developed aphasia and right-side hemiplegia and is still on follow up and under rehabilitation. Again, we realized the importance of DSA in which we could appreciate the collateral supply and prepare our self for bypass. Reconstruction of ICA at the site of aneurysm with multiple clips and wrapping of it with muscle graft was our back up plan but, patient's deteriorating conditions did not allow us to attempt that.

Giant atherosclerotic communicating segment aneurysm which required ICA reconstruction

Case 7: A 55 years female presented with right eye vision loss having giant atherosclerotic right communicating segment aneurysm involving inferior half circumference of ICA. Aneurysmal sac medially-extending into the sella with compression on optic chiasma, laterally-adherent to the tent with compression of third nerve, posteriorly-adherent to basilar artery into the interpeduncular fossa. Proximal temporary clip was applied. Incision was given on aneurysmal neck both medial and lateral to ICA leaving 1cm of neck on each side contiguous to wall of ICA to reconstruct the inferior vessel wall. Major part of the neck and sac were atherosclerosed with calcification. Permanent fenestrated right-angled clip applied to reconstruct the ICA, which kept on slipping due of atherosclerosis of neck. So, atherosclerotic plaques were removed with Penfield

dissector and ICA was reconstructed with three permanent fenestrated right-angled clips. Medial and lateral part of sac was excised but part in the interpeduncular fossa couldn't be removed keeping in mind the risk of injury to basilar artery. Post operatively patient had right anterior choroidal artery infarct with medical research Council (MRC) Gd 3 power in left side. Patient was discharged on 7th post op day. Patient was put on anti-platelets and after three weeks she started with hematuria in view of which anti-platelets were stopped and patient developed massive pulmonary embolism and expired. Figure 3 C&D, Figure 4.

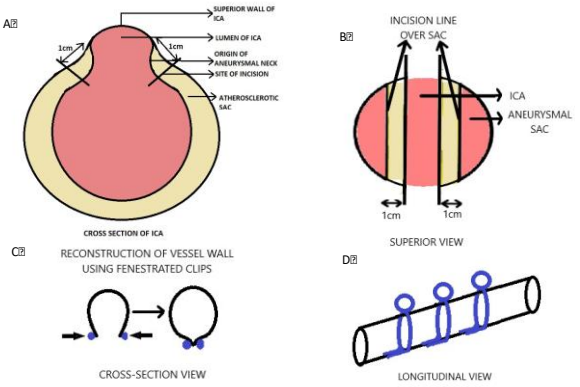

Figure 4. Sequential Artistic view of reconstruction of ICA in giant atherosclerotic communicating segment ICA aneurysm.

Conclusions

Intracranial aneurysms are challenging to manage due to their proximity to vital intracranial structures, the skull base, visual apparatus and difficulty in securing proximal control intra-cranially. They can be successfully clipped if the intimate anatomical relations of the aneurysm like the optic nerve, anterior clinoid process; optic strut, the dural ring and adjacent vessels are anatomically defined properly during surgery. Thorough knowledge of intracranial anatomy, adjacent relations, arachnoid planes and skillful dissection is a key element to successful outcome. Data collected from GGSMC & Hospital may not be representative of the entire state or country's population. Therefore, a larger-scale data collection is necessary to create our own database to ascertain the risk factors and preventive measures that are exclusive to our state and nation.

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