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Use of Flat Panel C-arm Angiographic System for Coiling of Intracranial Aneurysm: A Series of 20 Cases in a Single Tertiary Care Center

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ABSTRACT
Neuro-intervention for treatment of intracranial aneurysm has gone through a tremendous amount of growth and refinement both in techniques and devices. Retrospective analysis of 20 patients with intracranial aneurysm who underwent end oracular coiling using flat panel C-arm angiographic system in a single tertiary care center over a period of 2 years, march 2020 to February 2022. In a series of 20 patients with intracranial aneurysm 18 cases were successfully coiled, 2 cases had failure of procedure, 2 patients had post-procedure infarct and 1 patient expired. Though use of High-definition Cath lab for coiling of aneurysm is preferred mode but results obtained using flat panel C- arm angiographic system is equivalent, especially in centers where constraints in cost and space is the limiting facto.

INTRODUCTION

Endovascular coiling is one of the accepted modes of treatment for aneurysm. Advancements in the neuroendovascular devices that have made endovascular treatment for intracranial aneurysm more preferred treatment. Development of coils from bare platinum coil, cerecyte coil to hydro coil, detachable balloons and Guglielmi detachable coils are associated with significant improvement in endovascular coiling[1]. Endovascular coiling of large aneurysms is a relatively safe and feasible approach and is associated with lesser morbidity and mortality[2,3,4] Further development in techniques-microcatheters, flow diverters had increased the success rate of the procedure. The endovascular strategies divided into 2 groups: selective aneurysm treatment with coiling, balloon-assisted coiling (BAC), stent-assisted coiling (SAC), and flow diversion (reconstructive techniques) and 2) parent artery occlusion (PAO) (deconstructive technique), procedure is associated with two major complications, ischaemia and aneurysm rupture. Intra-procedure rupture is seen in 2-8.8 % cases in various studies[5,6,7,8]. Post-procedure related permanent complications being 4%.

MATERIALS AND METHODS

We retrospectively reviewed all patients who underwent endovascular coiling for intracranial aneurysm at our institute from March 2020 till February. In our study, we used C-arm angiographic system 31 cm * 31 cm CMOS flat panel X- ray detector for DSA and neurointervention (1,2). CMOS technology achieves higher spatial resolution due to smaller pixel size, with lower noise levels and a higher read-out speed at full resolution. System uses 19" duo-flat-screens for brightness and contrast even at a distance. It has improved maneuverability and with fewer cable system, it transfers live X-ray images to external monitors. With up to 25 frames per second. The C-arm provides crystal-clear images. The unique liquid cooling system (Advanced Active Cooling, AAC) supports the mobile C-arm during lengthy, demanding procedures. All patients admitted with spontaneous SAH are evaluated neurologically using WFNS grade and FISHER grade on the basis of CT scan. Clinical outcome is measured using mRS score, mRS score of grades 0-3 was considered favourable outcome, grade of 4-6 is considered unfavourable outcome. Some of the patients that were referred from other institute/department had CT angiogram diagnosed intracranial aneurysm, and rest of the patients were further evaluated by DSA.

Procedure: In our centre, all neuro-endovascular intervention is done under general anaesthesia and we prefer to do diagnostic DSA using left femoral access. Pre-procedure, we calculate the dimension of the aneurysm using 1) Wide exposure DSA in which both catheter tip and aneurysm is visualized. Then the measurement is taken in comparison to the catheter tip (we use 6F catheter for standard DSA). 2)DICOM (digital imaging and communication in medicine) software is also used for assessment. In comparison, both are found to be equivalent.

We use the right femoral artery to perform the procedure. Anticoagulant heparin 2500 IU was administered after the access of femoral artery using Angix femoral catheter of 7F followed by infusion of 1000 IU of heparin per 500 mL of 0.9% normal saline during the entire procedure. Continuous intravenous infusion of nimodipine at 5 ml/h was also administered throughout the procedure and continued postoperatively to prevent vasospasm. Large and giant aneurysms defined as those with diameter greater than 15 mm and 25 mm respectively as measured by DSA using our manual technique and DICOM software. All patients were analyzed regarding the size and type of aneurysm. In our center, we use a Cordis catheter of 5F and diagnostic guide wire of Terumo Radifocus. After cannulating, re-check DSA is done. After re-visualization of the aneurysm, a prowler microcatheter is introduced. The Neuroscout 14, micro-guidewire is used. Microcatheter is advanced over micro guide wire and is placed at the junction of inner 2/3 and outer 1/3 of the dome of the aneurysm, inside the aneurysm sac and then Orbital galaxy coil system is introduced and coiling of aneurysm is initiated. After the Coil is completely inside the aneurysm, it is then detached. Finally, finishing coils are placed to pack the aneurysm. Check DSA is done before terminating the procedure. Angiographic outcome was evaluated using Raymond class as complete obliteration (class I), residual neck (class II) and residual aneurysm (class III).

RESULTS AND DISCUSSIONS

Patient's Characteristics: 14 (70%) patients were female and 6 (30%) were male. In our study, all cases had ruptured aneurysms. Out of 20 patients, patients with WFNS grade 1 were 0, with WFNS grade 2 were 7, with grade 3 were 13 patients. Size of the aneurysm ranged from 1.6 to 3.2 cm. All aneurysms were saccular in nature. All patients underwent coiling, 2 patients had failure of procedure and underwent clipping. All patients had anterior circulation aneurysm. Out of 20 aneurysms, 11 were PCOM, 8 ACOM, and 1 MCA bifurcation aneurysm.

Clinical and Angiographic Outcome and Follow up: Every patient was assessed angiographically to assess the aneurysm status and patency of the parent vessels. The mRS score at the 6th month post procedure was

Table 1: Demography and angiographic characteristic of aneurysm

Patient's details	Diagnosis	Aneurysm Status	Characteristics of aneurysm	WFNS FISHR grade mRS status at admission	Procedure	Outcome	mRS status after 6 months of follow up
C. K. 65y/F H.no. PA2000027201	MCA bifurcation segment aneurys m	Ruptured	Saccular, 1.8* 1.6 cmm	WFNS-2mRS-2	Coiling was attempted	Coiling Failed developed infarct	mRS- 4
O. K. 75y/F PA 2000035739	Right para-PCO M aneurys m	Ruptured	Saccular, 2.0*1.6 cm	WFNS3 mRS-5	Coiling failed Clipping was done	Complete occlusion of aneurysm	mRS- 3
K.H 45y/M PA 2000049857	ACOM aneurys m	Ruptured	Saccular, 2.0*1.4 cm	WFNS-2 mRS-3	Coiling	Complete occlusion of aneurysm	mRS- 1
P. P. 62y/F PA 2000052549	Para PCO M aneurys m	Ruptured	Saccular, 2.0* 1.8 cm	WFNS-3 mRS-3	Coling	Complete occlusion of aneurysm	mRS- 1
S. B.59y/F PA 2000053372	ACOM aneurys m	Ruptured	Saccular, 2.4* 2.0 cm	WFNS2 mRS-3	Coiling	Complete occlusion of aneurysm	mRS- 1
R.D 42y/M PA 2000059535	ACOM aneurys m	Ruptured	Saccular, 2.6 * 2.2 cm	WFNS-3 mRS-5	Coiling	Complete occlusion of aneurysm	mRS-3
J. G 73y/M PA 2100001548	ACOM aneurys m	Ruptured	Saccular, 2.2* 2.0 cm	WFNS-3 mRS-5	Coiling	Complete occlusion of aneurysm	mRS- 5 Post-proce dure infarct
R.S 44y/F PA2100003685	PCOM aneurys m	Ruptured	Saccular, 2.2* 2.0 cm	WFNS-3 mRS-3	Coiling	Complete occlusion of aneurysm	mRS-1
K. M 58y/F PA 2100026534	ACOM aneurys m	Ruptured	Saccular, 1.8* 1.6 cm	WFNS- 3 mRS- 5	Coiling	Complete occlusion of aneurysm	mRS-2
P. D R 56y/F PA 2100039548	Right ICA aneurys m	Ruptured	Saccular, 2.4* 1.8 cm	WFNS- 3 mRS- 5	Coiling	Complete occlusion of aneurysm	mRS- 3
K.B 43y/F PA 2100039792	PCOM aneurys m	Ruptured	Saccular, 2.0* 1.6 cm	WFNS- 3 mRS- 3	Coiling	Complete occlusion of aneurysm	mRS- 1
A. K. 61y/F PA 2100044691	PCOM aneurys m	Ruptured	Saccular, 2.6* 1.8 cm	WFNS-3 mRS- 3	Coiling	Complete occlusion of aneurysm	mRS- 0
B. 61y/F PA 2100057398	PCOM aneurys m	Ruptured	Saccular,1.8* 2.0 cm	WFNS-3 mRS-5	Coiling	Expired	mRS- 6
M. B 52y/F PA 2100058618	PCOM aneurys m	Ruptured	Saccular, 2.7* 2.2 cm	WFNS2 mRS-2	Coiling	Complete occlusion of aneurysm	mRS- 1
J. B 48/F PA 2100062618	PCOM aneurys m	Ruptured	Saccular, 3.2* 2.6 cm,	WFNS-2 mRS-3	Coiling failed, dislodgement of microguidewire	Clipping of aneurysm	mRS- 4
N.S 49/M PA200052891	ACOM aneyrysm	RUPTURED	SACCULAR 1.7* 1.5CM	WFNS3 mRS5	coiling	Complete occlusion of aneurysm	mRS _5
A K M PA-2200028127	ACOM ANEURYSM	RUPTURED	SACCULAR 2.6*1.7	WFNS 3 mRS 3	coiling	Complete occlusion of aneurysm	mRS 4
P M PA 2200066636	P com aneurysm	ruptured	Saccular 2.1*1.3	WFNS 3 mRS 3	coiling	Complete occlusion of aneurysm	mRS 3
A. K PA-2100044692	P COM ANEURYSM	RUPTURED	SACCULAR 2*1.2	WFNS 3 mRS 2	coiling	Complete occlusion	mRS 3
A. T. S. PA -2200050392	ACOM Aneurysm	RUPTURED	SACCULAR 1.2*1.0	WFNS 3 mRS 2	coiling	Complete occlusion	mRS 3

assessed. Outcome of the procedure was measured with mRS staging. At time of admission mRS between 0-2 were 5 (25%) and 3-6 were 15 (75%) patients respectively. Overall morbidity and mortality were 2 (10 %) and 1 (5%) respectively. Overall improvement in neurological outcome was seen following 6 month follow up after procedure with mRS score between 0-2 were 8 patients (40%) and 3-5 were 11 patients (55%). The 1 patient who died in the hospital, developed massive femoral access site haematoma after 4 days of procedure, with drop in hemoglobin and platelets levels. Her coagulation profile also became deranged. To prevent this, we generally do standard DSA with left femoral access and coiling procedure with right femoral access. But for her we were unable to access the left femoral artery so the procedure of DSA and coiling was done from the same right femoral artery access. Despite no bleeding from the post procedure site after compressing for 20 minutes, later she developed hematoma. Possible explanation may be due to anticoagulation and anti-platelets during and after procedure. Despite correcting platelets, hemoglobin level and coagulation profile, she died later on.

Two patients had failure of procedure. First one had a slippage of the microcatheter tip from aneurysm fundus with inability to re-catheterize the aneurysm. The patient underwent craniotomy and clipping later on. Possible explanation may be due to our inexperience with the use of this system. The 2nd patient underwent intra-procedure vasospasm of the M1 segment while coiling for the M1-M2 segment aneurysm. Procedure was abandoned due to inability to microcatheterize the aneurysm. Check angiography was done after 1 week of attempt of aneurysm coiling, but aneurysm was not visualized and decreased flow in MCA territory was seen. Possible explanation is parent artery occlusion resulting in thrombosis of aneurysm. Later patient developed an infarction probably due to thromboembolism and decompressive hemicraniectomy was performed. One patient had a hardware issue. While inserting the coil system, there was pre-detachment of the coil extending from the PCOM aneurysm to ICA. The coil could not be retrieved. She was undertaken for emergency craniotomy and aneurysm was clipped, small arteriotomy was done in ICA and coil was retrieved. Patient later on developed MCA infarct with left hemiparesis which improved later on. On subsequent follow up she was able to walk with support. The patients were clinically followed for a mean of 12 months (range, 6-36 months) 1 patient expired after follow-up of 6 months. Etiology could not be established.

Clinical Outcome: All patients who underwent successful coiling didn't have recurrence till last follow up. A Meta-Analysis by F. Cagnazzo *et al*[3]. showed

aneurysm recanalization was 47% after reconstructive and 22% after deconstructive techniques. The rate of early aneurysm rupture after coiling was 8%, whereas no cases were described after deconstructive treatment. In our study, we didn't have any rupture of an aneurysm after coiling. All patients showed improvement in neurological outcome following the successful procedure and had shown improvement in mRS score. The incidence of ischemic events was slightly higher after deconstructive compared with reconstructive treatments (33% versus 18.8%) was seen in metaanalysis done by- F. Cagnazzo *et al*[3]. In our study, 2 (10%) patients developed infarct following the procedure. Patients' characteristics - size of the aneurysm, age, sex did not show any difference in outcome. Those patients with neurological deficiet and poor WFNS grade had poor outcome.

In our study, we have used C arm angiographic system RFD CMOS flat panel X-ray detector, for all the procedures of coiling. In general, DSA is done in a cath lab. Cath lab requires a large sum of money to establish and also incurs huge running coast. C arm angiographic system RFD flat panel used by us, comes for approx. ¼ th price of a standard high definition cath lab machine[9]. Moreover, establishing a cath lab requires a large sum of money and space associated with lot of electric and civil work. Flat panel C arm angiographic system RFD CMOS can be used in Operation theatre also. Any failure, or development of complication during the procedure can be converted into craniotomy and clipping of the aneurysm at the same place. In hospitals where the budget to establish the cath lab is not available and there is constraint in space, this C arm using a flat panel detector is the best option to achieve the goal, though there are limitations with it. 3-D reconstruction of the anatomy of aneurysm and vascular structure cannot be established and the C arm needs to be operated manually. To measure the size of aneurysm, DICOM software is needed which itself is an expensive software, though we use our own technique of comparing the aneurysm size with the diagnostic catheter size in a wide DSA view. In our center, results achieved with the C arm angiographic system are equivalent. It can also be used frequently, not only for coiling but also as a normal C arm for spine surgery with better resolution. Management of large aneurysms is still debatable and is a challenging task for cerebrovascular neurosurgeons. In our study, all patients for coiling had anterior circulation aneurysm. In our center, with limited supply of endovascular devices, as approved by the government, all being free for the patients, intervention needing balloon or stent assisted coiling cannot be done as these articles are not in supply. In our study cohort, we performed coiling successfully with packing of these aneurysms. Balloon and SAC techniques have been one of the milestones in the endovascular treatment of complex intracranial aneurysms[10] but due to lack of supply it cannot be done in our center. Flow-diversion devices represent the latest revolution in treatment of endovascular aneurysms and the treatment is changing from aneurysm embolization to parent vessel reconstruction especially in fusiform aneurysms[11].

CONCLUSION

Though High-definition Cath lab for coiling of aneurysm is preferred mode but results obtained using flat panel C-arm angiographic system for coiling of aneurysm is equivalent. Flat panel C-arm angiographic system RFD CMOS flat panel X-ray detector being cost efficient does not need a separate space for using the gadget. It can be easily used in operation theater with benefit of converting to open surgery if required following any complication. Disadvantage being 1-manually operated and 3-D reconstruction cannot be done. 2-Spatial resolution may not be equivalent to that obtained in high-definition Cath lab

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