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Endovascular Managment for Intracranial Carotid Artery Aneurysms

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ABSTRACT

Objective: To assess safety and effectiveness of endovascular managment for different types of intracranial carotid artery aneurysms.

Patients and Methods: prospective and retrospective review of intracranial carotid artery aneurysms treated by endovascular procedures in Al-Azhar University Endovascular Center and other centers. Twenty patients met inclusion criteria.

Results: fourteen medium sized, nine small, four large and one giant aneurysm. Seventeen narrow necks, eleven wide-necks and seven have involved branches in neck. Twenty-three cases were treated with coiling, three cases were treated with stent-assisted coiling and two cases were treated with stenting as flow diverter.

Conclusion: pre-procedural conscious patients with GCS15 or 14 associated with better outcome. PcomA, Ophthalmic and Choroidal aneurysms were associated with better outcome after endovascular procedures. Coiling of narrow neck aneurysms was associated with better outcome.

Keywords: cerebral aneurysm, endovascular techniques, wide-neck aneurysm, coiling, internal carotid artery aneurysms.

INTRODUCTION

An aneurysm is an abnormal focal dilatation of an artery, forms a focal discontinuity and a weak spot in the vessel wall, predisposing to aneurysm rupture, the most frequent cause of non traumatic subarachnoid hemorrhage (SAH)[1].

The prevalence of intracranial aneurysms is around 2% for adults without specific risk factors, 12% in patients with polycystic kidney disease, 7% with fibromuscular dysplasia, and 5% with syndromic connective tissues diseases (e.g. Ehlers-Danlos type IV)[2].

The rupture rate of unruptured cerebral aneurysms in the Familial Intracranial Aneurysm study cohort (1.2% per year) was approximately 17 times higher than the rupture rate for subjects with an unruptured cerebral aneurysm in the International Study of Unruptured Aneurysm Study (0.069% per year) with a matched distribution of aneurysm size and location[3]. Intracranial aneurysms are classified, according to their morphology, into saccular and nonsaccular aneurysms (fusiform and dissecting) and according to diameter into small, medium, large and giant [4].

The clinical presentation of aneurysmal SAH is often a severe headache of sudden onset, may be associated with nausea, vomiting, stiff neck, loss of consciousness, and focal neurological deficits including cranial nerve palsies, [5].

If SAH is detected in non-enhanced computed tomography (CT), computed tomographic angiography (CTA), magnetic resonance angiography (MRA) and digital subtraction angiography (DSA) is performed to detect possible underlying vascular pathology, DSA is the gold standard for evaluation of the arterial system.As approximately 20 to 30 percent of the ruptured aneurysms hemorrhage again within the first month after a SAH, the treatment of ruptured intracranial aneurysms is well grounded. The management of unruptured cerebral aneurysms is, however, still much more controversial because of incomplete and conflicting data about the natural history of these lesions and the risks associated with their treatment[4, 5]. The operative treatment of intracranial aneurysms falls into two main categories, namely microsurgical treatment and endovascular techniques. When an aneurysm is microsurgically clipped, the base of the aneurysm is closed by opposing the aneurysm walls. The goal of microsurgical aneurysm treatment is to achieve complete and permanent exclusion of the aneurysm from the circulation while preserving the parent artery and possible perforating or branching vessels arising from the parent vessel[6].

The purpose of endovascular aneurysm therapy is to exclude the aneurysm from the circulation either by endosaccular occlusion or by flow diversion and parent vessel reconstruction. The endovascular approach to aneurysm occlusion has the theoretical advantage of avoiding craniotomy and brain manipulation, but is nevertheless associated with numerous challenges (i.e. the risk of periprocedural aneurysm rupture, occurrence of arterial dissections and/or thromboembolic complications, reactions to contrast material, and puncture site complications)[7].

In the ISAT (the International Subarachnoid Aneurysm Trial) study, retreatment

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was 6.9 times more likely after endovascular therapy than after surgical clipping, the mean time to retreatment being 20.7 months [6].

There are several theoretical advantages in using stents in the management of intracranial aneurysms: in addition to reducing the risk of coil protrusion into the parent artery, an intracranial stent provides a physical matrix for possible endothelial growth across the aneurysm neck and disturbs the inflow jet to the aneurysm sac, thus promoting aneurysm thrombosis[8].

Stents are used mainly in two different situations: wide neck aneurysm and unfavorable anatomy. Wide neck aneurysm has been defined as a saccular aneurysm in the diameter of the neck larger than 4 mm, in which the dome–to neck ratio is less than 2[9].

As the use of antiplatelet medication is mandatory, significant controversy exists on the placement of intracranial stents in the acute phase of intracranial haemorrhage. If subtotal embolization of the aneurysm sac may be performed with coils only, a valuable strategy is to complete treatment with stent in a different session far from the subarachnoid haemorrhage. Other relative contraindications are exaggerated; vessel tortuosity, significant atherosclerotic disease and coagulation disorders[9].

AIM OF THE WORK

To assess safety and effectiveness of endovascular managment for different types of intracranial carotid arteryaneurysms.

PATIENTS AND METHODS

This is a prospective and retrospective study conducted on patients with intracranial carotid artery aneurysms; a consecutive series of (20) aneurysms were approached with endovascular therapeutictechniques. **The study was approved by the Ethics Board of Al-Azhar University.**

Data collection and processing:

During the period of the study (April 2017 to June 2018), data were collected and saved in summary sheets case by case. Hospital records and radiology films of the patients were electronically saved.

Clinical evaluation:

Initial clinical status of the patients was assessed according to the following:

Full history taking including:

- Personal data.
- History of medical co-morbidity and treatment.
- Family history of intracranial aneurysms.
- Presentation with stress on history.

Complete physical examination including:

- Vital signs including blood pressure.
- Conscious level assessment with GCS: The best response was documented.
- Ocular examination including fundus examination.
- Nuchal rigidity and other signs of meningeal irritation.
- Complete neurological examination.
- Clinical status of patients with or without SAH was graded according to WFNS scale.

Diagnosis of intracranial aneurysms: Diagnosis of large and giant intracranial aneurysms based on clinical and radiological evaluation.

Clinical evaluation:

Ruptured intracranial aneurysm lead to SAH which suspected with sudden severe headache associated with photophobia and neck stiffness or other signs of meningeal irritation. Aneurysmal SAH was diagnosed on the basis of the clinical characteristics of SAH with evidence of SAH in the CT scan.

Radiological evaluation:

1. CT scan: CT scan was the first choice for investigation of cases with clinically suspected SAH.

2. MRI: It was used to evaluate the cases of aneurysms with typical presentation of SAH with no evident blood in the CT, or other presentation rather than SAH or for follow up to detect complications early.

3. Angiography:

Diagnostic catheter cerebral angiography (digital subtraction angiography) was done for all patients with ruptured or unruptured aneurysms prior to the therapeutic procedure.

Good quality CTA and MRA were considered sufficient for diagnosis of the aneurysms and initiation of the process of providing fund. However, the final treatment strategy was not planned without evaluation of the aneurysm by catheter angiography.

Measurements were done using software programs allowing measurement of the chosen distances in reference to a known catheter diameter (catheter calibration).

In our study, aneurysm morphology was described as saccular, nonsaccular and blister. By saccular aneurysm we mean aneurysms arising from part of the circumference of the artery usually with neck, sac and fundus.

The aneurysm width/ neck ratio was used for categorization of the aneurysms in the study into: (a) narrow neck aneurysms: < 4mm or dome/neck ratio > 2 and (b) wide neck aneurysms: ≥ 4mm or dome/neck ratio ≤ 2. Etiology was categorized as: (a) idiopathic, (b) dissecting.

Preprocedural evaluation and preparation:

Clinical and laboratory assessment of the patients‟ medical status including: CBC with platelet, Prothrombin time (PT)/activated partial thromboplastin time (a PTT) and INR, renal function tests, liver function tests. Arterialblood gases, Serum chemistries, including electrolytes and osmolarity was done before some procedures.

Clopidogrel at a dose of 75 mg/day started and acethyl-salicic acid (ASA) of 150 mgat least 4 days prior to the procedure. On table 300 mg rapid loading dose of clopidogrel was done for patient with recent history of rupture.

Informed consent:

Informed consent was obtained from all patients (and/or related responsible person) before all procedures. It included:

1. Simple explanation of the procedure and possible complications with notification to the radiation hazards and contrast adverse reactions.
2. Other options for diagnosis (e.g. CTA) and treatment (e.g. surgical clipping).

Guiding catheters:

Guiding catheters were used in procedures for adult cases and 8 F guiding was if semi-jailing technique was decided and the two microcatheter was introduced from one sheath. All guiding catheters were connected to a continuous flush system via Y-connector that continuous flush system via Y-connector that allows introduction of the interventional devices through the catheter.

Flush solution was prepared by adding 1000 U of heparin to a 500 ml bag of normal saline. 10 ml of nimodipine solution (NimotopTM) was added to the first bag.

The prepared bag was wrapped by pressure cuff with pressure exceeding the systolic blood pressure of the patient.

Guiding wires:

Types of guide wire used in this study were as following:

1. Zip wire 150 cm, 0.035 inch (Boston Scientific/ Target). 260 cm wires were used or exchange of diagnostic catheters with guiding catheters.
2. Terumo.
3. Aqwire (ev3, Irvine, CA, USA).

Decision making:

Endovascular treatment was considered indicated whenever it seemed feasible. Reconstruction of the arterial system by occlusion of the aneurysm with preservation of the parent artery the reconstructive approach (either endoluminalwith or without endosccular reconstruction) was the goal of this study.Surgical treatment was favored in few instances including the following cases:

1. When there is large ICH necessitating surgical evacuation, surgical clipping was performed in the same operation.
2. Unavailability of the required fund for the endovascular treatment was considered an indication of surgical clipping.
3.

Techniques:

Formal diagnostic cerebral angiography was done at the beginning of the procedure using a diagnostic catheter.

A guiding catheter was used for cannulation of the appropriate ICA. It was advanced as high as the skull base (beginning of the petrous segment. Fargo guiding catheter can be advanced as high as clinoidal segment). In contrast to the case with diagnostic catheters, a guide wire was usually used with the guide catheter; this was thought to reduce the risk of spasm of the ICA during catheter navigation.

The guiding catheter is then connected with a continuous flush system via a Y-connector as mentioned before. When vasospasm was encountered with catheter navigation, speeding up the rate of Nimotop containing flush solution and waiting for few minutes was usually sufficient in eliminating the vasospasm.

A working angle was chosen before introduction of the microcatheter. Sometimes, multiple working angles were used. The working angle was determined by obtaining images in multiple projections according to the aneurysm configuration and the planned procedure. When 3D reconstruction angiography was available, the working angle was easily chosen from the 3D image.

Reconstructive procedures: All cases were subjected to reconstructive procedure (either endoluminalwith or without endosccular reconstruction).

Standard aneurysm coiling:

Before introduction of the microcatheter, steam shaping of the catheter tip was done in all cases. Shape of the catheter tip was usually made with two obtuse angles. To obtain the desired shape, the shape was usually exaggerated to compensate for loss of part of the curves after removal of the shaping mandrel.Themicrocatheter was then introduced over a wire through the Yconnector of the guiding catheter. Using road mapping technique, the microcatheter was navigated through the cerebral arteries up until cannulationof the aneurysm. The microcatheter was aimed at a central position within the aneurysm.

Systemic heparinization was started with introduction of the first coil. 5000 units were given followed by 1000 unit every hour. Coils were introduced into the aneurysm with and without road mapping, depending on the condition. Coiling proceeded until angiographic total occlusion of the aneurysm was achieved or risk of encroachment of the coil mass on the parent artery or a normal branch adjacent to the aneurysm was imminent or limitation of supplies.

Stenting:

The microcatheterwasintroduced over a wire through the Y-connector of the guiding catheter by same way as coiling but navigation proceed until crossing the neck of aneurysm, then the stent introduced through the microcatheter and deployed pulling the microcather and pushing the mounted wire (pull- push maneuver).different stenting techniquewas used as: trans cell coiling, coiling and stenting, stenting alone either denovo or previously coiled aneurysms and semijailing. Failure of semi-jailing technique was noted.

Postoperative care:

After recovery from anesthesia, patient was transferred to neurosurgery ICU for overnight observation. Patient hydration was maintained; the renal function was checked in the second day after the procedure.

Oral acetyl salicylic acid 150 mg was started in the first postoperative day for all patients. Acetyl salicylic acid was continued for at least one year, clopidogryl 75 mg was also given orally for 3 to 6 months.

Assessment of technical feasibility:

The treatment was considered technically feasible if at least one stent could be deployed; otherwise it was categorized as technical failure. Also there some procedural difficulties changing the original plan to other one.

Outcome evaluation:

Clinical outcome assessment

To assess clinical outcome, the Glasgow Outcome Scale (GOS) score was recorded at discharge and at follow-up. Telephone communication was used when considered sufficient.

Procedure-related morbidity was documented when there is a new neurological deficit that lasts more than 7 days and was attributable to the procedure.

Outcome was classified further as either favorable (with GOS score 4 or 5) or unfavorable (with GOS score <4).Presenting symptom of unruptured aneurysms was also be assessed pre and in follow up.

Radiological outcome assessment:

Assessment was done by recording the degree of aneurysm occlusion**.** Degree of occlusion was recorded in the final control angiography and in angiographic follow up. Stasis was graded according to stasis arm of OKM grading scale.

CASE PRESENTATION

Case No. 1

Male Patient 61 yrs old hypertensive not diabetic Presented by Headache on Lt fronto-temporal region of gradual onset and progressive course, dull aching character and awake patient from sleep associated with history of DCL and drooping of Lt eyelid of 4 months duration.

General and Neurological examination reveals NAD

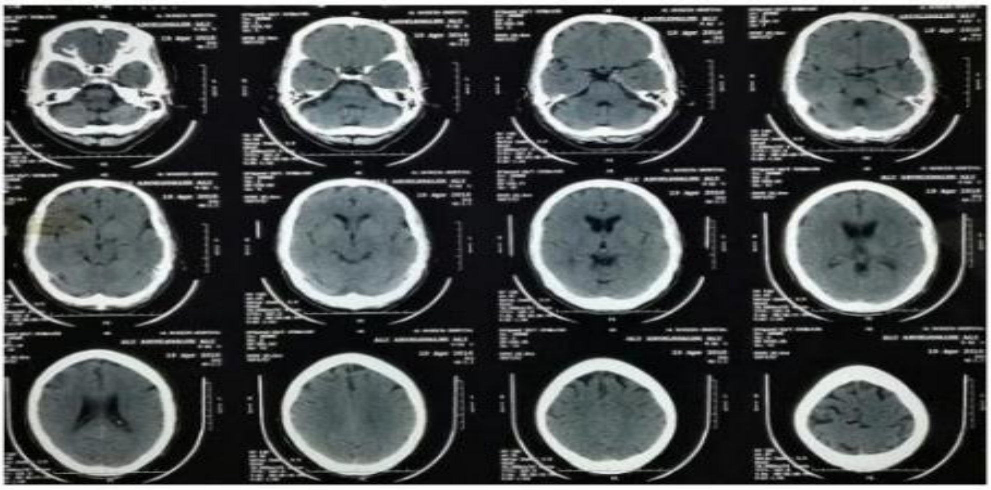

Figure (1): Preoperative Brain CT (plain axial cuts)

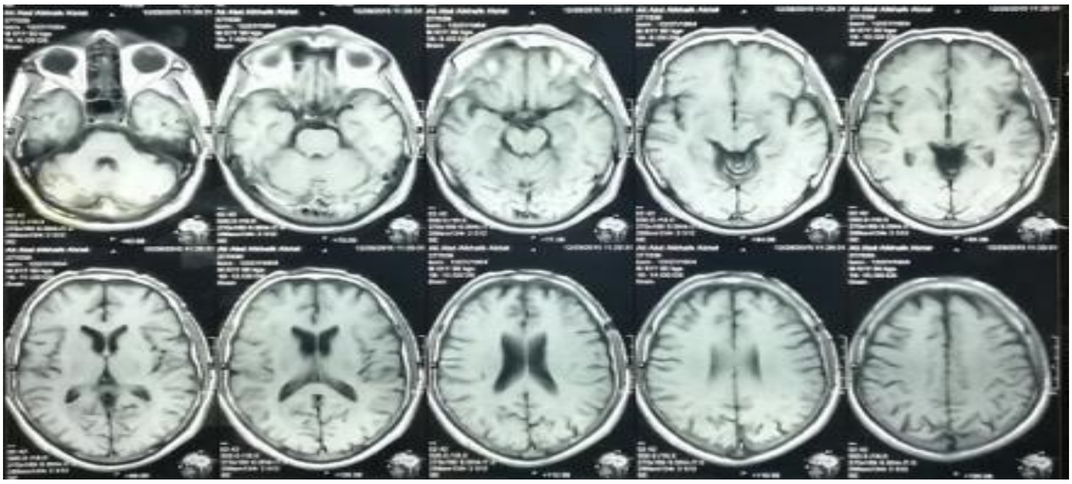

Figure (2): Pre operative Brain MRI (T1 without contrast axial cuts)

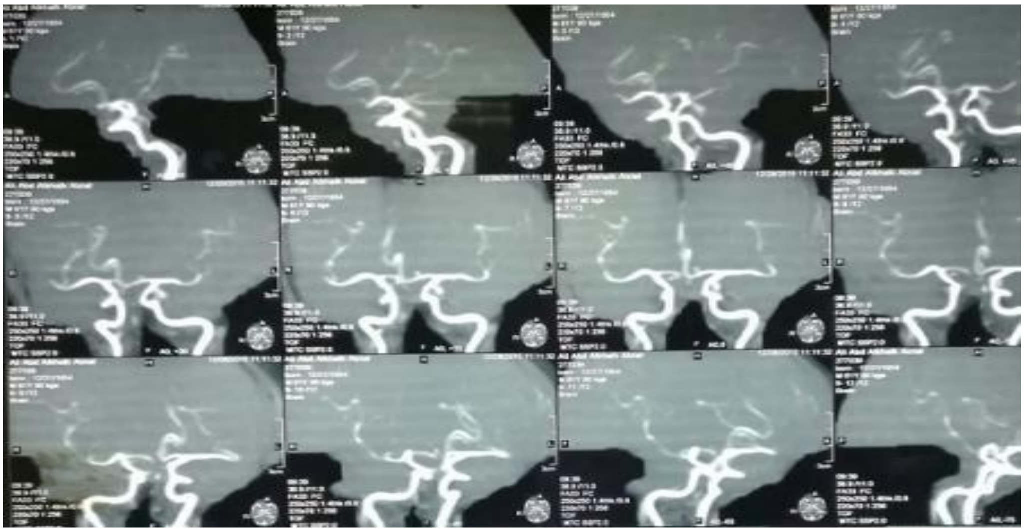

Figure (3): Preoperative Brain MRangiography showing Lt bilobedsaccularPcom aneurysm.

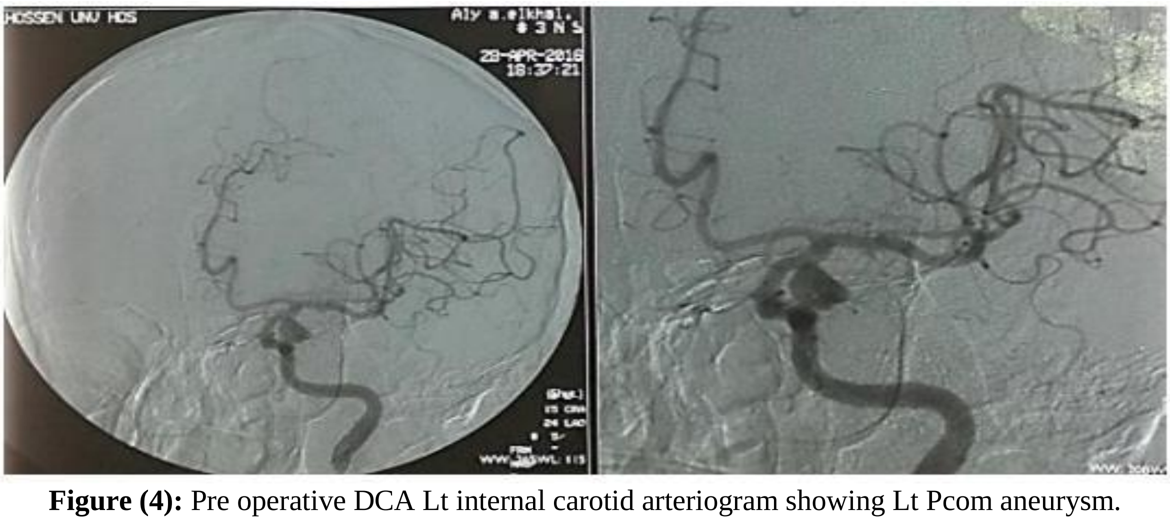

Figure (4): Pre operative DCA Lt internal carotid arteriogram showing Lt Pcom aneurysm.

Coiling of the aneurysm done and 90% occlusion of the sac by 7 coils:

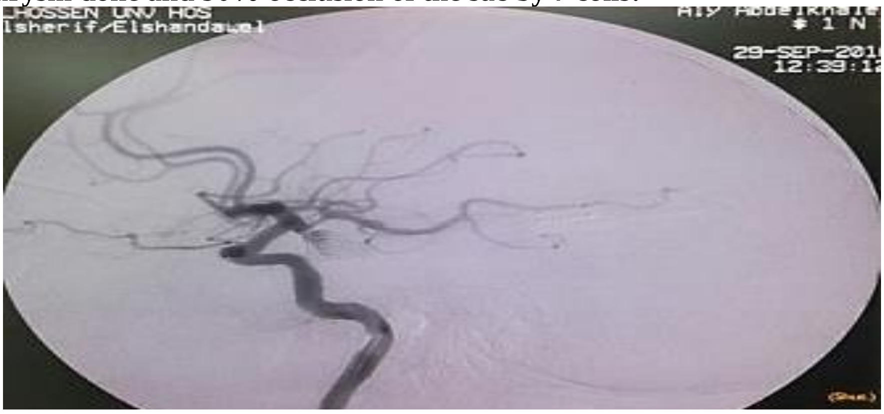

Figure (5): Intra operative DSA Lt internal carotid arteriogram showing more than 90% occlusion of Lt Pcom aneurysm.

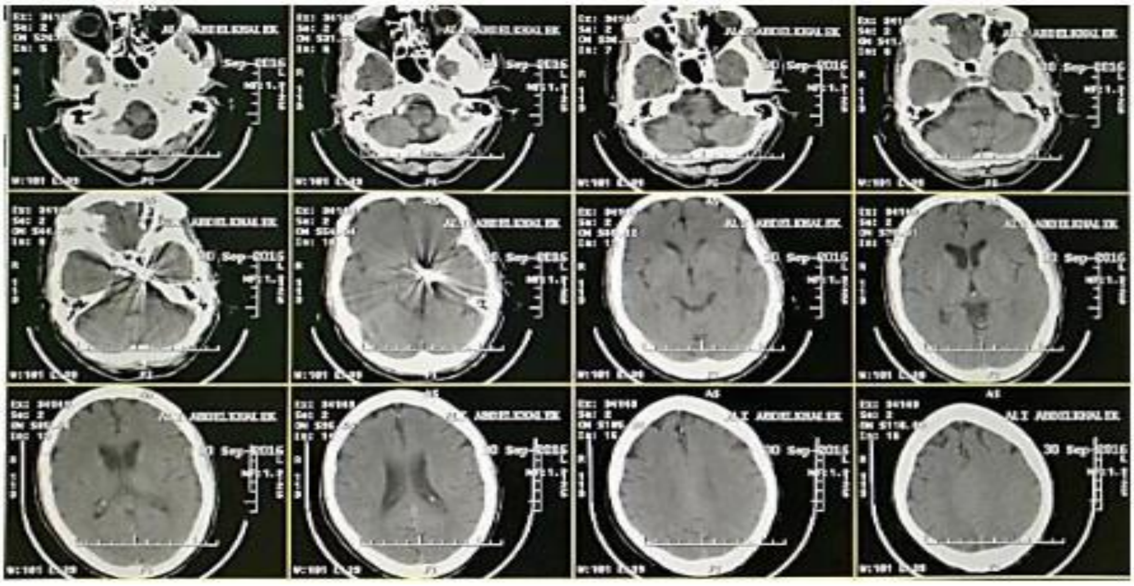

Figure (6): Post operative Brain CT (plain axial cuts) showing radiopaque metallic coils in Lt Pcom site.

Patient discharged fully conscious and full power without any neurological deficit.

Case No. 2:

Female patient 45 yrs old not known to be diabetic not hypertensive presented by sudden onset of severe headache, throbbing in character, increased by noise associated with DCL and vomiting of 5 hrs duration.

General and neurological examination revealed disturbed uncooperative patient GCS 14/15.

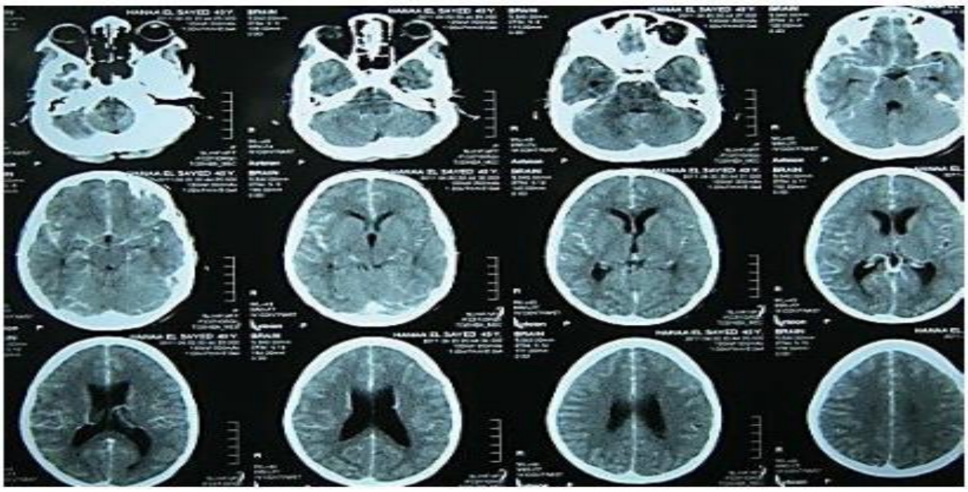

Figure (7): Pre operative Brain CT (plain axial cuts) showing SAH.

Figure (8): Pre operative DSA Lt internal carotid arteriogram showing Lt Pcom aneurysm.

Patient operated by stent-assisted coiling technique with occurance of intra operative perforation.

Figure (9): Intra operative DSA Lt internal carotid arteriogram showing total occlusion of Lt Pcom aneurysm and properly applied stent

Patient discharged fully conscious and full power without any neurological deficit

Statistical analysis

Data were analyzed using Statistical Program for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

Chi-square (X^2) test of significance was used in order to compare proportions between two qualitative parameters.

- Probability (P-value)
- P-value ≤0.05 was considered significant.
- P-value ≤0.001 was considered as highly significant.
- P-value >0.05 was considered insignificant.

RESULTS

Age: About eighty two percent of patients from 30 to 60 years old (n=20), three patients (15%) above 60 years and two patients (10%) below 30 years.

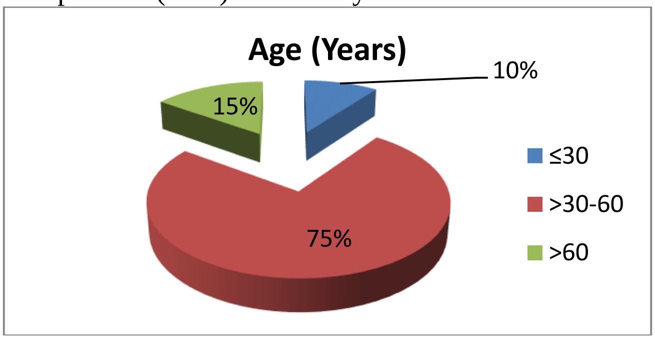

Figure (10): Pie chart age (years) distribution of the study group.

Gender Distribution: Fifty percent of patients were males(n=10) and others were females (n=10).

Table (1): Demographic data distribution of the study group

Demographic data	No (N=20)	%
Gender		
Female	10	50.0
Male	10	50.0
Age (years)		
≤30 years	2	10.0
>30-60 years	15	75.0
>60 years	3	15.0
Total	20	100.0
Range [Mean±SD]	13-70 [51.44±12.63]	

This table shows that the female (50%) and male (50%) of sex, also age <30 (7.1%), >30-60 years (82.1%) and >60 years (10.7%).

Aneurysm morphology and endovascular techniques:

Standard coiling used in all cases with width/neck ratio >1 (n=17), Fifty four percent of patients had aneurysms with width/neck ratio ≤1 and eighty five percent of patients had aneurysms with involved branches in neck. Stent-assisted coiling used in twenty seven percent of cases had aneurysms with width/neck ratio ≤1.

Stenting as a flow diverter used only in eighty percent of patients had aneurysms with width/neck ratio ≤1 and Fourteen percent of patients had aneurysms with involved branches in neck.

Table (2): Relation between aneurysm morphology and endovascular techniques:

Procedure / Morphology	Standard coiling	%	Stent-assisted coiling	%	Stenting	%	Total
W/N ratio > 1	17	100	0	0	0	0	17
W/N ratio ≤ 1	3	54.5	2	27.2	1	18.1	3
Involved branches in the neck	6	85.7	0	0	1	14.2	7
Involved branches in the dome	0	0	0	0	0	0	0

Clinical outcome:

About ninety percent of cases (n=25) had proper outcome without any neurological deficit, one case with moderate disability, one case with severe disability and one case in coma.

Table (3): Clinical outcome:

Glasgow outcome score	Number	Percentage
GOS 5	**17**	**89.3 %**
GOS 4	**1**	**3.5 %**
GOS 3	**1**	**3.5 %**
GOS 1	**1**	**3.5 %**

Radiological outcome:

Fifty seven percent of patients (n=16) had total occlusion of aneurysms, twenty five percent of patients (n=7) had near total occlusion of aneurysms, ten percent of patients (n=3) had about 70% occlusion of aneurysms, one case had about 50% occlusion and one case had about 30% occlusion of aneurysm.

This evaluation was done in different periods ranged from early post-operative to 1 year.

Table (4): Radiological outcome

Grade of occlusion	Number	Percentage
0	**12**	**57.1 %**
1	**4**	**25 %**
2	**2**	**10.7 %**
3	**1**	**3.5 %**
4	**1**	**3.5 %**

Complications:

Seven percent of cases (n=2) died one of them due to cardiac problem (inferior MI) and other admitted DCL GCS 10/15 not improved, Intraoperative perforation occurred in twenty one percent of patients (n=6), thrombosis, recanalization and iatrogenic carotid cavernous fistula occurred each in one case.

Table (5): Complications:

Complication	Number	Percentage
Intraoperative perforation (IOP)	**3**	**21.4 %**
Thrombosis	**1**	**3.6 %**
Recanalization	**1**	**3.6 %**
Iatrogenic CCF	**1**	**3.6 %**
Mortality	**1**	**7.1 %**

According to demographic data and outcome:

The relation of patient's age to the outcome of endovascular procedures shows thatYounger age was associated with better clinical outcome; however, it was not statistically significant (*p* = 0.175). See table 4.

The relation of patient's gender to the outcome of endovascular procedures shows that Females were associated with better clinical outcome; however, it was not statistically significant (p = 0.339) in neurological outcome and (p = 0.538) in radiological outcome. See table 5.

According to associated diseases and outcome:

The relation of associated hypertension and diabetes mellitus to the outcome of endovascular procedures shows thatAbsence of co-morbidity was associated with better clinical outcome; however, it was not statistically significant (p = 0.82). See table 6.

According to presentation:

Patients whose didn't presented with DCL were associated with better outcome; that was statistically significant (p <0.001) in radiological outcome and statistically insignificant (p =0.783) in neurological outcome. See table 7.

According to aneurysm factors:

The relation of location of aneurysm to the outcome of endovascular procedures shows thatPcomA, Ophthalmic and Choroidal aneurysms were associated with better outcome; that was statistically significant (p =0.037) in neurological outcome and also statistically significant (p <0.001) in radiological outcome. See table 8.

Coiling of narrow neck aneurysms associated with better neurological outcome; that was statistically significant (p =0.047). See table 9.

Table (6): Relation between age (years) and outcome of the study group

Outcome / Age		Neurological outcome				Radiological outcome						Total
		GOS 1	GOS 3	GOS 4	GOS 5	0	1	2	3	4	with Anterior cerebral infarction	
≤30 years	No.	0	0	0	2	1	1	0	0	0	0	2
	%	0.0%	0.0%	0.0%	7.1%	3.6%	3.6%	0.0%	0.0%	0.0%	0.0%	7.1%
>30-60 years	No.	1	1	0	13	8	3	1	1	1	1	15
	%	3.6%	3.6%	0.0%	75%	46, 4%	17.8%	7.1%	3.6%	3.6%	3.6%	82.1%
>60 years	No.	0	0	1	2	1	1	1	0	0	0	3
	%	0.0%	0.0%	3.6%	7.1%	3.6%	3.6%	3.6%	0.0%	0.0%	0.0%	10.7%
Total	No.	1	1	1	17	11	4	2	1	1	1	20
	%	3.6%	3.6%	3.6%	89.3%	53.6%	25.0%	10.7%	3.6%	3.6%	3.6%	100%
Chi-square test		8.976				3.339						**x2**
		0.175				0.972						**p-value**

Table (7): Relation between gender and outcome of the study group:

Outcome / Gender		Neurological outcome				Radiological outcome						Total
		GOS 1	GOS 3	GOS 4	GOS 5	0	1	2	3	4	with Anterior cerebral infarction	
Male	No.	1	1	1	7	4	2	1	1	1	1	10
	%	3.6%	3.6%	3.6%	39.3%	21.4%	14.3%	3.6%	3.6%	3.6%	3.6%	50%
Female	No.	0	0	0	10	7	2	1	0	0	0	10
	%	0.0%	0.0%	0.0%	50%	32.1%	10.7%	7.1%	0.0%	0.0%	0.0%	50%
Total	No.	1	1	1	17	12	3	2	1	1	1	20
	%	3.6%	3.6%	3.6%	89.3%	53.6%	25.0%	10.7%	3.6%	3.6%	3.6%	100%
Chi-square test		3.360				4.076						**x2**
		0.339				0.538						**p-value**

Table (8): Relation between presentation and outcome of the study group:

Outcome / Presentation		Neurological outcome				Radiological outcome						Total
		GOS 1	GOS 3	GOS 4	GOS 5	0	1	2	3	4	0 with Anterior cerebral infarction	
DCL	No.	1	1	0	8	5	2	1	1	0	1	10
	%	3.6%	3.6%	0.0%	42.9%	25%	14.3%	3.6%	3.6%	0.0%	3.6%	50%
Diminution of vision on Rt eye	No.	0	0	0	1	0	0	0	0	1	0	1
	%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	3.6%
Headache	No.	0	0	1	8	6	2	1	0	0	0	9
	%	0.0%	0.0%	3.6%	42.9%	28.8%	10.7%	7.1%	0.0%	0.0%	0.0%	46.4%
Total	No.	1	1	1	17	11	5	1	1	1	1	20
	%	3.6%	3.6%	3.6%	89.3%	53.6%	25.0%	10.7%	3.6%	3.6%	3.6%	100%
Chi-square test		3.200				30.602						**x2**
		0.783				<0.001						**-value**

Table (9): Relation between location and outcome of the study group:

Outcome / Location		Neurological outcome				Radiological outcome						Total
		GOS 1	**GOS 3**	**GOS 4**	**GOS 5**	**0**	**1**	**2**	**3**	**4**	**0 with Anterior cerebral infarction**	
ICA bifurcation	No.	0	0	0	1	1	0	0	0	0	0	1
	%	0.0%	0.0%	0.0%	3.6%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%
A1	No.	1	0	0	0	0	1	0	0	0	0	1
	%	3.6%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	3.6%
MCA	No.	0	0	0	1	0	0	0	1	0	0	1
	%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	3.6%
C4	No.	0	0	0	1	0	0	0	0	1	0	1
	%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	3.6%
Ophth.	No.	0	0	0	1	1	0	0	0	0	0	1
	%	0.0%	0.0%	0.0%	7.1%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%
Choroidal	No.	0	0	0	1	1	0	0	0	0	0	1
	%	0.0%	0.0%	0.0%	7.1%	3.6%	0.0%	3.6%	0.0%	0.0%	0.0%	7.1%
PcomA	No.	0	0	0	6	3	2	1	0	0	0	6
	%	0.0%	0.0%	0.0%	28.6%	17.9%	7.1%	3.6%	0.0%	0.0%	0.0%	28.6%
AcomA	No.	0	1	1	6	4	2	1	0	0	1	8
	%	0.0%	3.6%	3.6%	35.7%	21.4%	14.3%	3.6%	0.0%	0.0%	3.6%	42.8%
Total	No.	1	1	1	17	10	5	2	1	1	1	20
	%	3.6%	3.6%	3.6%	89.3%	53.6%	25.0%	10.7%	3.6%	3.6%	3.6%	100%
Chi-square test		30.8				66.244						**x2**
		0.037				<0.001						**p-value**

DISCUSSION

Many studies suggest advanced age is associated with poor outcome after SAH. However, other studies demonstrate that young and old people in the same clinical condition experience similar outcomes. There are several important caveats when examining the association between age and outcome: (1) older patients are frequently excluded from active treatment; this influences outcome, (2) older patients are more often in poor clinical grade, which has a greater impact on outcome than age; and (3) other variables such as hypertension or atherosclerosis are common in elderly patients; these factors may have an independent adverse effect on outcome or in multivariate analysis replace the effect of age[10]**.** Our study performed on 20 cases with anterior circulation aneurysms treated by endovascular procedures. In this study, the relation of patient's age to the outcome of endovascular procedures was evaluated. Younger age was associated with better clinical outcome; however, it was not statistically significant (p = 0.175).

This goes in accordance with literatures that concluded that younger patients are more likely to have normal mental outcome after aneurysm treatment [11]**.**

And according to **Wiebers *et al.***[4]; overall, morbidity and mortality were the highest in patients older than age of 50 years.

Subarachnoid hemorrhage is more common in women than in men (2: 1) with the peak incidence occurring in persons 50 to 60 years old[12]**.**

In this study, there was equal gender distribution: The role of hypertension in aneurysm formation and rupture has been controversial. The concept of hypertension increasing the risk for hemorrhage makes intuitive sense. In 1995, Taylor and colleagues described the demographics and prevalence of hypertension in 20, 767 Medicare patients with un-ruptured aneurysms and compared these results with a random sample of hospitalized Medicare population. For patients with an un-ruptured aneurysm as the primary diagnosis, hypertension was found to be a significant risk factor for future SAH. In summary, recent data support an association between systemic hypertension and increased risk for rupture of un-ruptured aneurysms[13]**.**

In this study, the hypertensive cases were 12 patients (57%) andthe relation of associated diseases to the outcome of endovascular procedures was evaluated. Absence of co-morbidity was associated with better clinical outcome; however, it was not statistically significant (p = 0.82).

The GCS is the clinical grading system of this study:

And the relation of pre-procedural Glasgow coma score to the outcome of endovascular procedures was evaluated. Conscious patient with GCS15 or 14 associated with better outcome; that was statistically significant (p =0.033) in neurological outcome and statistically insignificant (p =0.301) in radiological outcome. Nimodipine, administered orally or via a nasogastric tube, 60 mg every 4 hours and continued for 3 weeks, is standard treatment of patients with aneurysmal SAH because it has a modest but statistically significant beneficial impact on clinical outcome[14].

All patients with ruptured intracerebral aneurysms were treated with nimodipine orally for 3 weeks. Some type of cardiovascular abnormality develops in most patients with SAH. Hypertension and hypotension are common and occur in 27% and 18%, respectively. Other cardiovascular events include life threatening arrhythmias, myocardial ischemia, and successful resuscitation from cardiac arrest. Electrocardiographic (ECG) abnormalities are very common after SAH. The spectrum of ECG changes includes ST-segment alteration, T-wave changes, prominent U waves, QT prolongation, conduction abnormalities, and sinus bradycardia and tachycardia. These ECG changes were not associated with overall morbidity and mortality in one study. Neurogenic stunned myocardium, a severe cardiac injury that can occur in patients with SAH, is characterized histologically by contraction band necrosis, which is a reversible cardiac pathology often found in patients who die after SAH. This histologic change is characteristic of heart muscle exposed to excessive catecholamines and intracellular calcium and leads to a hypercontracted state [15].

In this study there was one case died by inferior myocardial infarction. The most common form of endovascular management is the deployment of the detachable coils into the aneurysm via microcatheter. These coils cause local thrombosis and isolation of the aneurysm from the parent artery. Patients that are ideal candidates for the use of coils are aneurysms with a narrow neck (<4 mm) and low dome-to-neck ratio (<2)[16].

In this study standard coiling was used in eighty two percent of cases (n=23). Aneurysms with a narrow neck are generally considered more suitable for coil embolization. There are several factors that are important for determining whether the patient is a candidate for endovascular coil embolization. Aneurysms with a dome to neck ratio of less than 2 have a higher rate of incomplete coil embolization. Also related to this are aneurysms with a neck width >4 mm; they also represent a less likely chance of having complete embolization coiling. Aneurysms that are multilobulated are more difficult to treat with coil embolization than spherical aneurysms. When the parent or branch vessels are incorporated into the aneurysm, the chances of achieving complete coil occlusion of the aneurysm will decrease[17].

In this study, coiling of narrow neck aneurysms associated with better neurological and radiological outcome; that was statistically significant (p =0.047) neurologically and (p =0.047) radiologically. Intraprocedural aneurysm rupture is reported to occur in 2–8% of cases[18].

In this study intra-operative aneurysm perforation was twenty one percent. This higher percent may be due to selection of cases with complete radiological and clinical data and there were two studies in our department shows results around ten percent nearest to the literature.

Although, this high rate of IOP all cases were managed perfectly and discharged without any deficit. The reported rates for procedural thromboembolic complications following endovascular treatment of cerebral aneurysms range from 2.7% to 17% [2].

Thromboembolic complications have been reported as occurring in 2.5–28% of patients[19].In this study thrombosis occurred in three percent only (n=1). This patient improved on medication and physiotherapy. Re-canalization of embolized aneurysms has been reported at a wide range of frequencies in the literature, ranging from 10% to 50%, with an average of 20–35%. Re-canalization is affected by size, with greater stability seen in small embolized aneurysms and lesser stability in large and giant aneurysms[20].

In this study re-canalization occurred in three percent only (n=1) after 6 months follow up. Overall complication rate of aneurysm embolization is about 10%, with permanent complication rate of 3-5%, mainly as follows: intracranial arterial occlusion, intraoperative aneurysm rupture, aneurysm re-bleeding, puncture point bleeding, coil shift and vasospasm[21].

In the large series of **Henkes *et al.***[2], complications occurred in 16% of the procedures for ruptured aneurysms and in 19% of the procedures for unrupturedaneurysms.In this study overall complication was thirty nine percent (n=11) and permanent complication was seven percent (n=2). This may be due to selection of cases with complete radiological and clinical data which often complicated cases properly recorded for further investigation and evaluation. Most of intra-operative complication occurred in early cases due to aggressive maneuver and low experience. Even that high rate of complications all cases were managed without any deficit, only seven percent morality (n=2) one of them admitted with DCL GCS 10 and the other died with inferior MI and one patient (3.6%) discharged hemiparetic and improved on follow up.

CONCLUSION

- Pre-procedural Glasgow coma score influence the outcome of endovascular procedures as conscious patients with GCS15 or 14 associated with better outcome; that was statistically significant (p =0.033) in neurological outcome and statistically insignificant (p =0.301) in radiological outcome.
- PcomA, Ophthalmic and Choroidal aneurysms were associated with better outcome after endovascular procedures; that was statistically significant (p =0.037) in neurological outcome and also statistically significant (p <0.001) in radiological outcome.
- Coiling of narrow neck aneurysms associated with better outcome; that was statistically significant (p =0.047), (p =0.042) in neurological and radiological outcome respectively.

RECOMMENDATION

- Extension of the study to involve larger number of cases with different modalities in our community to evaluate all endovascular techniques.
- The time job now is to continue such studies on broad cases to produce complete guidelines of endovascular techniques on evidence-based rules.

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