Endovascular Techniques for Different Morphological Types of Anterior Circulation Aneurysms

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Abstract: Introduction: Endovascular techniques of embolization of different morphological types of anterior circulation aneurysms as regard width to neck ratio, dome and neck branches involvement. **Methods:** Retrospective and prospective review of anterior circulation aneurysms treated by endovascular procedures in Al-Azhar University Endovascular Center and other centers. **Results:** Twenty eight patients met inclusion criteria. 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. Pcom A, Ophthalmic and Choroidal aneurysms were associated with better outcome after endovascular procedures. Coiling of narrow neck aneurysms was associated with better outcome.

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Introduction:

Anterior circulation aneurysms arise from the internal carotid artery or from any of its branches; the most common type is saccular, responsible for 85% of anterior circulation aneurysms. Microsurgery and endovascular approach are the two ways for treatment in these patients. Prevalence of intracranial aneurysms is estimated to be from 1% to 5% of population, most of them are small and located in the anterior circulation.[12]

Aneurysm:

The term „aneurysm" comes from the Greek, meaning a „widening", and it most commonly refers to a pathologic dilatation or out pouching of an artery. An aneurysm is defined as a localized and persistent dilatation of the arterial blood vessel wall, and it is formed by dilatation of the constituents of the vessel wall, which exhibit profound structural alterations.[14]

Classification

Classification of intracranial aneurysms may be based on morphology, size, location and etiology.[22]

According to morphology

Intracranial aneurysms classified according to its morphology into:

1. Saccular aneurysms.

Saccular aneurysm are berry-like vessel represent up to 97% of Intracranial Aneurysms, and are associated to the branching points of the parent vessel.[9]

2. Fusiform aneurysms.

Fusiform aneurysms are dilated, tortuous and elongated arterial segments. Fusiform aneurysms are a relatively uncommon form found in the anterior circulation. It may found at (supraclinoid internal carotid artery and middle cerebral artery), they more frequently found in the posterior circulation at the distal vertebral artery, basilar artery, P1 segment of the posterior cerebral artery.[2]

3. Dissecting aneurysms.

The literature contains multiple variations of aneurysm nomenclature that reflect the pathophysiological mechanisms of aneurysm formation, such as dissecting aneurysms, serpentine aneurysms, atherosclerotic aneurysms, mycotic or infectious aneurysms, and traumatic aneurysms.[9]

According to size

Intracranial aneurysms classified according to its size into:

1. Small aneurysms. are ≤5 mm in diameter.
2. Medium size aneurysms. are 5-15 mm in diameter.
3. Large aneurysms. are 15–25 mm in diameter.
4. Giant aneurysms. are 25-50 mm in diameter.
5. Supergiant aneurysms. are ≥50 mm in diameter.[13]

According to location

Intracranial aneurysms classified according to its location into:

1. Anterior circulation (85–95%).

Anterior communicating complex: (30%).
Cavernous carotid artery: (3–5%).
Ophthalmic segment of internal carotid artery: (5%).
Posterior communicating artery: (10–25%).
Middle cerebral artery: (20%).
Internal carotid artery terminus: (5–10%).
Distal anterior cerebral artery: (3%).
2. Posterior circulation (5–15%).
Basilar apex (tip): (8–15%).
Basilar trunk: (1–5%).
Vertebral artery and Posterior inferior cerebellar artery: (5%).[14]

2. Patient and Methods:

The study was done retro and prospectively in Al Azhar endovascular center and other centers on twenty eight cases admitted with anterior circulation aneurysms. The study was carried out to assess the most probable endovascular technique in different aneurysm morphology as regard safety and efficacy.

3. Results:

The anterior circulation aneurysms differentiate to multiple types according to morphological characters, although appearance of numerous shape and sizes of aneurysms in anterior circulation the most frequently used endovascular technique of embolization is the standard coiling technique which become the cornerstone of endovascular management of all morphological types of anterior circulation aneurysm whether ruptured or not.

But there are few types of flat wide neck aneurysm and aneurysms in complex structural region of circle of willis may limit the choice of standard coiling technique.

The flow diversion, stent-assisted coiling and balloon-assisted coiling or onyx embolization didn't take the whole chance for us to can assess them precisely.

Our study performed on 28 cases with anterior circulation aneurysms treated by endovascular procedures.

Coiling procedure was performed in 89% of the procedures, stent-assisted were performed in 11% of the procedures and stenting were performed in 7% of procedures.

Although the incidence of procedure-related complications was 32%, only 11% had postoperative unfavourable outcome. 93% of the patients were associated with favourable outcomes after 3 months.

Reported complications were: intraoperative rupture (IOR): 21%, intraoperative thrombosis: 3.6%, iatrogenic carotid cavernous fistula (CCF): 3.6% and mortality: 7.1%.

57.14% of aneurysms had occlusion grade 0, 25% had grade 1, 10.7% had grade 2, 3.6% had grad 3, and 3.6% had grade 4.

According to demographic data and outcome:

The relation of patient's age to the outcome of endovascular procedures shows that Younger age was associated with better clinical outcome; however, it was not statistically significant ($p = 0.175$).

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.

According to associated diseases and outcome:

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

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.

The relation of pre-procedural Glasgow coma score to the outcome of endovascular procedures reveals that 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.

According to aneurysm factors:

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

The relation of size of aneurysm to the outcome of endovascular procedures shows that Large and medium sized aneurysms were associated with better outcome; however, it was not statistically significant ($p = 0.794$) neurologically and ($p = 0.5067$) radiologically.

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

Also Coiling of narrow neck aneurysms associated with better radiological outcome; that was statistically significant ($p = 0.042$).

The relation of W/N ratio and intra-operative complication with procedure of treatment shows that Coiling of narrow neck aneurysms associated with

lesser intra-operative complication than wide-neck aneurysms; however, it was not statistically significant (p = 0.333).

Coiling of aneurysms with involved branches in the neck associated with better neurological outcome; however, it was not statistically significant (p = 0.749).

Also Coiling of aneurysms with involved branches in the neck associated with better radiological outcome; however, it was not statistically significant (p = 0.370).

The relation of involved branches in the neck and intra-operative complication with procedure of treatment appears that Coiling of aneurysms with involved branches in the neck associated with lesser intra-operative complication; however, it was not statistically significant (p = 0.846).

4. 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]

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.[18]and according to Wiebers et al, Overall, morbidity and mortality were the highest in patients older than age of 50 years.[3]

It has long been recognized that cerebral aneurysms occur more frequently in females than in males. With respect to gender and rupture rate, several studies suggest that female gender increases the risk for rupture. The mete-analysis of nine studies found a higher rupture rate in women, with a relative risk of 2.1. In addition, it was found that female gender was an independent risk factor for rupture of cerebral aneurysms. However, in a large analysis of hospital data, it was found that gender was not a predictor for risk of hemorrhage.[20]

Subarachnoid hemorrhage is more common in women than in men (2: 1) with the peak incidence occurring in persons 50 to 60 years old.[21]

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. [1]

In this study, the hypertensive cases were 16 patients (57%) and the 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).

Several clinical grading scales have been developed, including the Botterell, Hunt and Hess, and World Federation of Neurological Societies (WFNS) scales. None are universally accepted despite numerous analyses. Challenges in the development of a universal grading scale include significant interobserver and intraobserver variability and omission of important additional features that may be predictive of outcome but too complex to include in a clinical grading scale.[16]

Clinical grading is useful for estimating prognosis, for standardizing assessment to facilitate communication between physicians, and possibly for improving outcome measures in multicenter studies. Finally, repeated standardized assessment with some type of semiquantitative neurological scale is essential to detect deterioration in patient's condition. The neurological grade may best be determined after the patient is resuscitated and has undergone ventricular drainage if necessary. Neurological grade is an independent predictor of outcome after aneurysmal SAH. Assessment of level of consciousness with the Glasgow Coma Scale (GCS), which is the basis of the WFNS scale, was based on the observation that in a large clinical trial, the clinical features that best predicted outcome were the level of consciousness and the presence of a focal neurological deficit. The GCS is probably the most useful aspect of the grading scale.[17]

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.[4]

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.[19]

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).[23]

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.[7]

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.[11]

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%.[6]

Thromboembolic complications have been reported as occurring in 2.5–28% of patients.[8]

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.[15]

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.[5]

In the large series of Henkes et al. (2004)[6], complications occurred in 16% of the procedures for ruptured aneurysms and in 19% of the procedures for unruptured aneurysms.

In this study overall complication was thirty nine percent (n=11) and permanent complication was seven percent (n=2).

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.

Pcom A, 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.

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