Management of Intracranial Aneurysms and Subarachnoid Haemorrhage: Literature Review and Guidelines

ASHRAF MAHMOOD, SYED MUZAFFAR HASSAN KIRMANI
Department of Neurosurgery, SIMS / Services Hospital, Lahore

INTRODUCTION

Egas Moniz discovered an aneurysm by cerebral Angiography in 1933.[1]

Cushing introduced first aneurysmmal clip in 1911, Mayfield modified the existing spring clip with cross leg (Schwartz) by making it a smaller, tweezer – like applicator.[2]

An intracranial vascular procedure was first reported with aid of operating microscope which introduced simultaneously magnification and illumination.[3]

Dott in 1933 performed 1st planned intracranial surgery for a saccular aneurysm.[4]

Dandy in 1937 clipped the neck of aneurysm with a metallic clip.[5]

Yasirgill of Zurich and Drake of London Ontario, published a lot on aneurysms of anterior and posterior circulation.[6,7]

An elaborated study of natural history of aneurysm was published by the Pakarinen in 1967.[8]

Surgical Classification of Intracranial Aneurysms

1. **Morphology**

(i). Saccular. (ii). Fusiform. (iii). Dissecting.

2. **Size**

(i) <3mm (ii). 3-6mm (iii). 7-6mm (iv). 11-25mm. (v) >25mm (Giant).

3. **Location**

A. ***Anterior Circulation Arteries.***

i. *Internal Carotid*
   a. Carotid Canal.
   b. Intracavernous.
   c. Paraclinoid (Ophthalmic).
   d. Posterior Communicating region.
   e. Anterior Choroidal region.
   f. Carotid Bifurcation.

ii. *Anterior Cerebral*
   a. A_1 (mainbranch).
   b. Anterior Communicating region.
   c. A_2 (distal); callosomarginal/distal pericallosal region.

iii. *Middle Cerebral*
   a. M_1 (main branch) lenticulostriate/ temporal branch regions.
   b. Bifurcation.
   c. Trifurcation / Peripheral.

B. ***Posterior Circulation Arteries***

i. *Vertebral*
   a. Main Trynk.
   b. Posterior inferior cerebellar artery region.

ii. *Basilar*
   a. Bifurcation.
   b. Superior Cerebellar artery region.
   c. Anterior inferior cerebeller artery regions.
   d. Basilar trunk.
   e. Vertebro basilar junction region.

iii. *Posterior Cerebral*
   a. P_1 (first branches of basilar – distal to apex).
   b. P_2 (distal posterior cerebral).

The definite study of the natural history of aneurysms was published by Pakarinen in 1967.[9]

Etiology

A. **Hemodynamic**
   1. Uneven pulsatile pressure head distribution at apex of bifurcations, branching, or outer aspect of curves, causing local degeneration of internal elastic.
   2. Increase flow from.
      a. Distal arteriovenous malformation.
      b. Aplasia, hypoplasia of contralateral normally presenr vessel.
   3. Increased blood pressure (possibly associated vessel defect).
      a. Coarctation of aorta.
      b. Autosomal dominant polycystic kidney disease.
      c. Fibromuscular dysplasia.

B. **Genetic**

Genetic or Possibly genetic syndromes associated with intracranial aneurysms: Ehlers – Danlos. Syndrome, Marfan,s syndrome, Pseudoxanthoma elasticum, Rendu – osler – weber syndrome. Klippel – trenaunary – Weber syndrome, type – III collagen deficiency.

C. **Traumatic**
   a. Skull Fractures.
   b. Penetrating foreign body.
   c. Surgical injury.

D. **Infectious**
   a. Bacterial (5% mostly streptococcal infection in bacterial endocardits).
   b. Fungal.
   c. Syphilis.

E. **Neoplastic**
   a. Metastatic: choriocarcinoma, atrial myxoma.
   b. Primary neoplasm.
   c. Aneurysms associated with neoplasm; pituitary adenomas.

F. **Other Disorders, Effecting Blood Vessels**
   a. Granulomatous (giant cell) angitis.
   b. Systemic lupus erythematosus.
   c. Moyamoya disease.
   d. Sickle cell anemia.

G. **Radiation – Induced Seccular Aneurysm**

H. **Atherosclerosis** most common cause of fusiform aneurysm, posterior circulation most commonly affected.

Grading Scales for Subarachnoid Haemarrhage

The most important factors predictor outcome after SAH, were level of consciousness & presence of hemipresis and/or aplasia.

Numerous grading systems have been devised including mainly Botterell scale, Hunt and Hess scale World Federation of Neurological Surgeon scale area.[10] Hunt and Hess scale and surgical risk most often indicated by Neurosurgeons are as under:

Grade Description

1. Asymptomatic or minimal headache and slight nuchal rigidity.
2. Moderate to severe headache, nuchal rigidity, no neurological deficit other than cranial nerve palsy.
3. Drowisiness, confusion, or mild focal deficit.
4. Stupor, moderate to severe hemiparesis, possible early decrebrate rigidity and vegetative disturbances.
5. Deep coma, decerebrate, moribund appearance.

World federation of Neurological Surgeons Scale.

Grade Description

1. Glasgow coma score 15, no motor deficit.
2. Glasgow coma score 13 to 14, no motor deficit.
3. Glasgow coma score 13 to 14, with motor deficit.
4. Glasgow coma score 7 to 12, with or without motor deficit.
5. Glasgow coma score 3 to 6, with or without motor deficit.

Natural History of Aneurysms

Highest mortality is observed immediately following hemorrhage and diminishes later on. Asymptomatic aneurysms discovered incidentally/existing in patients with multiple aneurysms bleed at rate of 1-2%. Because the risk of surgery for unruptured aneurysms is low (mortality close to 0% morbidity about 04%).

It is recommended that asymptomatic aneurysms should be clipped in most patients.

Endovascular Treatment (Coiling) [16]

Surgical treatment to prevent rebleeding consists of clipping of the ruptured berry aneurysm. Endovascular treatment (coiling) is an increasingly practiced alternative to clipping, so the neurosurgeon/ neurointerven-

tionalist must be involved early in the care of patient with an aneurysmal subarachnoid haemorrhage (SAH).

Neurological Complications of Aneurysmal Rupture

There are summarized as below:

1. **Intracranial Pressure Elevation**

   Increased ICP, after Subarachnoid haemarrhage or Intraventricular Haemarrhage is usually due to an increase in CSF outflow resistance. Presumably, erythrocytes and fibrin debris from haemarrhage into subarachnoid space acutely block arachnoid villilae. Hydrocephalus is probably due to fibrotic obliteration of CSF path ways at many points.

2. **Hydrocephalus**

   It may be acute (treated by external ventricular drainage) or chronic with neurological sign (treated by ventriculoperitoneal shunt).
3. **Vasospasm.**
4. **Recurrent Subarachnoid Haemarrhage.**
5. **Epilepsy.**
3. **Focal Ischemic Neurological Deficit.**
4. **Disability or Death.**

Negative Work up for Aneurysm as a Cause of Subarachnoid Haemarrhage

In spite of availability of modern 4 vessel angiography, 3D CT angiography, digital subtraction angiography, magnification, multiple projection, attention to lesion in the spinal canal as a possible source of Subarachnoid Haemarrhage, in 05 series reported between 1986 and 1989, a source of subarachnoid haemarrhage could not be identified between 3.8 to 30% of patients.

Microsurgical Anatomy

Three basic principals should be reviewed in relation to each of the common aneurysmal site.

1. These aneurysms arise at branching site on the parent artery.
2. These aneurysms arise at a turn or curve in the artery. These curves by producing local alteration in intravascular hemedynomics exert unusual stresses on apical regions, which receive the greatest force of the pulse wave.
3. The saccular aneurysms point in the direction that blood would have gone if the curve at the aneurysm site were not present. The aneurysm dome or fundus points in the direction of maximal hemodynamic thrust in the preaneurysmal segment of the parent artery. So for neurosurgeon operating on aneurysm, the proximal and distal arterial control is of paramount importance.

Anatomic Principles of Aneurysmal Surgery

1. The parent artery should be exposed proximal to aneurysm.
2. If possible, the side of parent vessel opposite the side of aneurysm should be exposed **before** dissecting the neck of aneurysm.
3. The aneurysmal neck should be dissected before the fundus.
4. All perforating branches should be separated from the aneurysmal neck prior to passing the clip around the aneurysm.
5. Progressive suction of CSF from the subachronoid space should be used as a measure to relax the brain preferably. The mean arterial pressure should be reduced up to 90 – 105 mm Hg at the time of clipping and can be again allowed to rise after the successful application of the clip at neck of aneurysm to elicit and deal accordingly any ooze in periclipped aneurysmal site.
6. If rupture occurs during microdissection, bleeding should first be controlled by applying small cotton pledget and concomitantly reducing mean arterial pressure. If this fails, a temporary clip can be applied to the proximal already exposed artery but only for a brief time.
7. A clip with spring mechanism allows to be removed, reposition and reapplied.
8. The clip should not kink or obstruct the major vessel and no perforating branches are included.
9. Abroad based neck aneurysm may need bipolar coagulation to reduce the neck size.

Operative Approaches

95% of aneurysm are found at one of the five sites, all of which are located in close proximity to the circle of Willis these sites are:

1. The ICA between the PCOM and the arterior choroidal arteries.
2. The ACOM area.
3. The proximal bifurcation of MCA.
4. The internal carotid bifurcation.
5. The basilar bifurcation.

   A. **Pterional Approach:** The frontotemporal craniotomy with slight magnification in mostly

suitable for all these aneurysm arising from the anterior circle of Willis.

A small frontotemporal flap centered at the pterion may be used for ICA aneurysm and can be modified per-op for different aneurysm of MCA, ICA, ACOM and extended as:

a. Subtemporal approach for an aneurysm of basilar apex.
b. Anterior subtemporal exposure for upper basilar aneurysm.
c. Combined supra and infratentorial pre sigmod approach to basilar artery.

Imaging of Intracranial Aneurysm

1. In the past plain radiography was the first radiological investigation undertaken in patients suspectted of having intracranial aneurysm and these were reviewed for displacement of pineal body or choroid pleseus secondary to an intracerebral or subarachnoid Haemarrhage. Very rarely calcification was seen in the walls of a giant aneurysm. In a small percentage, bony eresions of the clivus, pituitary fossa, or sphenoid wing indicated a giant aneurysm.
2. High resolution computed tomography.

Recently this is the procedure of choice for the detection of Subarachnoid Haemarrhage.

Localization of intracranial aneurysm Liliequist b, Lindqvist M. Computed tomography in the evaluation of Subarachnoid Haemarrhage.[13-15]

The CT scan can be performed in first 24 hours of the attack. It can be done without and with IV contrast.

Ultrathin slices specially at circle of Willis are taken.

Unenhanced CT Scan

This will demonstrate Subarachnoid Haemarrhage areas of increased density in the subarachnoid spaces along the skull base, Sylvian fissure, within the sulci, along the falx, tentorium and even in interhemispheric f issuer.

The location of subachronoid hammrhage mostly suggest the site of bleeding aneurysm.

Enhanced CT Scan (CTA)

CTA is very useful for the diagnosis of aneurysms. These are performed after the view of unenhanced CT scan by giving I/V contrast.

Bolus Contraindications

1. Sensitivity to I/v contrast.
2. 2-Renal shut down.

Aneurysm greater than 5mm can be seen.

Transfemoral Cerebral Angiography

This may be the final step and can be performed immediately preceding surgery. Selective injection of 6 – 10 ml into common carotid and vertebral arteries may reveal circle of Willis.

Arterial, capillary and venous plases help in proper lacalisation of aneurysm.

Magnetic Resonance/magnetic (MRI) Magnetic Resonance Angiography (MRA).

MRI and MRA have become very useful diagnostic tools in addition to CT Scan and Angiography limitation.

Limitations

1. MRI donot identify fresh subarachnoid haemarrhage.
2. It is difficult to subject acutely sick aneurysm patient in MRA suit. However spasm may reduce the specificity of cerebral aneurysm/ parent vessel in MRA. Inspite of this MRI vascular and MRA are excellent studies to detect unruptured aneurysm.

   Time – of flight (TOF) or phase contrast (PC) are two techniques utilized in MRA. Both can be two or three dimensional acquisition. MRA study is a non invasive, cost effective way to detect the presence of aneurysm larger than 3mm in diameters. It is also a highly useful post operative follow up to see the result.

Address for Correspondence:
Dr. Ashraf Mahmood
Associate Professor
Department of Neurosurgery
SIMS / Services Hospital Lahore
Email: drashraf1964@gmail.com

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AUTHORS DATA

Name	Post	Institution	E-mail	Role of Authors
Dr. Ashraf Mahmood	Associate Prof.	Department of Neurosurgery, SIMS/Services Hospital, Lahore	drashraf1964@gmail.com	Writing of Paper
Dr. Muzaffar Hassan Kirmani	House Surgeon			Research of Literature