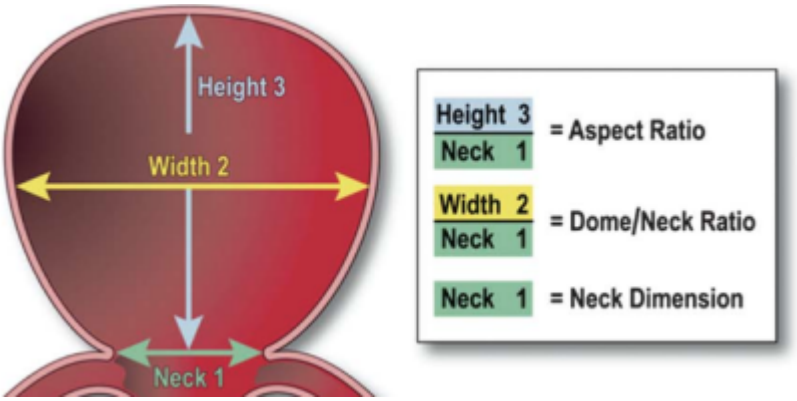
Saccular intracranial aneurysm



Also known as berry aneurysms, are intracranial aneurysms typically with a characteristic rounded shape and account for the vast majority of intracranial aneurysms. They are also the most common cause of spontaneous subarachnoid hemorrhages.

Epidemiology

see Saccular aneurysm location

see Saccular intracranial aneurysm epidemiology.

Pathology

Grossly aneurysms are rounded lobulated focal outpouchings which usually arise at the arterial bifurcations, it may arise from the lateral wall.

Most of the intracranial aneurysms are true aneurysm. The aneurysmal pouch is composed of thickened hyalinised intima with the muscular wall and internal elastic lamina being absent as the normal muscularis and elastic lamina terminate at the neck of the aneurysm. As the aneurysm grows it may become irregular in outline, and may have mural thrombus. Typically rupture occurs from the dome.

see Ruptured saccular intracranial aneurysm

Hemodynamic concepts

In contrast to saccular aneurysms, fusiform aneurysms represent a distinct subset of intracranial aneurysms with unique underlying pathological features, hemodynamic forces, anatomical distribution, as well as natural history that governs their treatment. [1)]

Aneurysms form as a result of an interplay between hemodynamic factors, such as axial stream impingement and the water hammer effect, and structural weaknesses at apices of arterial bifurcations, such as congenital and acquired medial defects, funnel-shaped dilatations, and areas of

thinning. Hypertension and time aid the formation of aneurysms. Unknown factors in women and in some families also play a role. Enlargement of aneurysms results from an interplay between mechanical factors, such as self-excitation and resonance, that produce structural fatigue and pathological processes of repair of the aneurysmal wall. Rupture of aneurysms is caused by the same hemodynamic factors that effect growth and is also influenced by extramural pressure. Pathologically, a major rupture may be preceded by fibrinous and leukocytic infiltration of the wall, bleb formation, and a minor hemorrhage. Such minor leaks can be followed by healing and growth. Aneurysms that escape major hemorrhage or heal successfully after a hemorrhage can grow to giant proportions, but remain susceptible to rupture despite their size, unless they become completely thrombosed. Intramural thrombosis may be stimulated by minor leaks and is dependent upon the physical characteristics of aneurysms [2)].

Hemodynamic stress

Especially high wall shear stress, loaded on arterial bifurcation sites is recognized as a trigger of IA formation from studies performed in the field of fluid dynamics. On the other hand, many studies using human specimens have also revealed the presence of active inflammatory responses, such as the infiltration of macrophages, in the pathogenesis of IA. Because of these findings, recent experimental studies, mainly using animal models of IA, have revealed some of the molecular mechanisms linking hemodynamic stress and long-lasting inflammation in IA walls. Currently, Fukuda et al., proposed that IA is a chronic inflammatory disease regulated by a positive feedback loop consisting of the cyclooxygenase (COX)-2 - prostaglandin (PG) E2 - prostaglandin E receptor 2 (EP2) - nuclear factor (NF)-κB signaling pathway triggered under hemodynamic stress and macrophage infiltration via NF-κB-mediated monocyte chemoattractant protein (MCP)-1 induction. These findings indicate future directions for the development of therapeutic drugs for IAs [3)].

Pathogenesis

Saccular Intracranial Aneurysm Pathogenesis

Associations

Numerous associations have been identified, most relating to abnormal connective tissue. Associations include:

Ehlers-Danlos syndrome (type IV) Marfan syndrome (controversial 3) autosomal dominant polycystic kidney disease (ADPKD) 1 coarctation of aorta 2 bicuspid aortic valve neurofibromatosis type 1 (NF1) 3 hereditary haemorrhagic telangiectasia alpha 1 antitrypsin deficiency 3 cerebral arteriovenous malformation: flow related aneurysm fibromuscular dysplasia Location

Cerebral aneurysms typically occur at branch points, usually of sizable vessels, but sometimes at the origin of small perforators which may not be seen on imaging. Approximately 90% of such aneurysms arise from the anterior circulation 4.

anterior circulation: ~90% ACA/ACoA complex: ~30-40% supraclinioid ICA and ICA/PCoA junction: ~30% MCA (M1/M2 junction) bi/trifurcation: ~20-30% posterior ciculation: ~10% basilar tip SCA PICA

Radiographic features

Berry aneurysms can be imaged in a variety of methods:

CT angiography (CTA) MR angiography (MRA) digital subtraction (catheter) angiography (DSA) Each of these confers certain advantages and disadvantages, although in general digital subtraction catheter angiography, especially with 3D acquisitions, is considered the gold standard in most institutions.

CT

The appearance depends upon presence of thrombosis within the aneurysm.

aneurysm appears as well defined round, slightly hyper-attenuated lesions. calcification can be present post contrast patent aneurysm: bright and uniform enhancement thrombosed aneurysm: rim enhancement due to filling defect MRI

On MRI also the patent and thrombosed aneurysm display different imaging features:

T1

most of the patent aneurysm appears as flow void, or they may show heterogeneous signal intensity. in thrombosed aneurysm appearance depends on the age of clot within the lumen. T2

typically hypointense laminated thrombus may show a hyperintense rim Required description on a radiology report

Regardless of the modality used, a number of features need to be assessed to allow a decision in relation to treatment to be made.

size: ideally 3 axis maximum size measurements neck: maximal width of the neck of the aneurysm shape and lobulations orientation: the direction in which the aneurysm points is often important in both endovascular and surgical planning any smaller branches in the vicinity of the aneurysm any branch taking off from the aneurysm Treatment and prognosis

Treatment of large or symptomatic aneurysms is with either endovascular coiling or surgical clipping.

Management of small aneurysms is controversial. At less that 7mm in maximal diameter aneurysms are statistically unlikely to rupture, however due to their prevalence anyone working in the area has seen numerous patients with small aneurysms which have ruptured resulting in subarachnoid haemorrhage, often with devastating consequences.

5 year cumulative risk of rupture of anterior circulation aneurysms 5:

<7 mm: 0% 7-12 mm: 2.6% 13-24 mm: 14.5%

> 25 mm: 40%

5 year cumulative risk of rupture of posterior circulation aneurysms 5:

<7 mm: 2.5% 7-12 mm: 14.5% 13-24 mm: 18.4%

> 25 mm: 50%

As such management will vary according to local experience, the location and appearance of the aneurysm, patient demographics etc...

Differential diagnosis

When the abnormality has been confirmed to be vascular, the differential includes:

fusiform aneurysm

infundibulum: usually triangular dilatation with the vessel arising from the apex

Dissecting aneurysm

mycotic aneurysm

See also

aneurysm ruptured berry aneurysm subarachnoid haemorrhage (SAH) vasospasm (post SAH)

3% of the population develops saccular intracranial aneurysms (sIAs), a complex trait, with a sporadic and a familial form. Subarachnoid hemorrhage from sIA (sIA-SAH) is a devastating form of stroke. Certain rare genetic variants are enriched in the Finns, a population isolate with a small founder population and bottleneck events. As the sIA-SAH incidence in Finland is >2× increased, such variants may associate with sIA in the Finnish population.

Kurki et al. tested 9.4 million variants for association in 760 Finnish sIA patients (enriched for familial sIA), and in 2,513 matched controls with case-control status and with the number of sIAs. The most promising loci (p<5E-6) were replicated in 858 Finnish sIA patients and 4,048 controls. The frequencies and effect sizes of the replicated variants were compared to a continental European population using 717 Dutch cases and 3,004 controls.

They discovered four new high-risk loci with low frequency lead variants. Three were associated with the case-control status: 2q23.3 (MAF 2.1%, OR 1.89, p 1.42×10-9); 5q31.3 (MAF 2.7%, OR 1.66, p 3.17×10-8); 6q24.2 (MAF 2.6%, OR 1.87, p 1.87×10-11) and one with the number of sIAs: 7p22.1 (MAF 3.3%, RR 1.59, p 6.08×-9). Two of the associations (5q31.3, 6q24.2) replicated in the Dutch sample. The 7p22.1 locus was strongly differentiated; the lead variant was more frequent in Finland (4.6%) than in the Netherlands (0.3%). Additionally, they replicated a previously inconclusive locus on 2q33.1 in all samples tested (OR 1.27, p 1.87×10-12). The five loci explain 2.1% of the sIA heritability in Finland, and may relate to, but not explain, the increased incidence of sIA-SAH in Finland. This study illustrates the utility of population isolates, familial enrichment, dense genotype imputation and alternate phenotyping in search for variants associated with complex diseases [4)].

Risk factor

see Intracranial aneurysm risk factor

Case series

In 47 cases of verified ruptured saccular aneurysm, Fisher et al. investigated the relationship of the amount and distribution of aneurysmal subarachnoid hemorrhage detected by computerized tomography to the later development of cerebral vasospasm. When the subarachnoid hemorrhage was not detected or was distributed diffusely, severe vasospasm was almost never encounters (1 of 18 cases). In the presence of subarachnoid blood clots larger than 5 X 3 mm (measured on the reproduced images) or layers of blood 1 mm or more thick in fissures and vertical cisterns, severe spasm followed almost invariably (23 of 24 cases). There was an almost exact correspondence between the site of the major subarachnoid blood clots and the location of severe vasospasm. Every patient with severe vasospasm manifested delayed symptoms and signs. Excellent correlation existed between the particular artery in vasospasm and the delayed clinical syndrome. Severe vasospasm involved the anterior cerebral artery in 20 cases and the middle cerebral artery in only 14. As the grading system used is partly subjective, the findings should be regarded as preliminary. The results, if confirmed, indicate that blood localized in the subarachnoid space in sufficient amount at specific sites is the only important etiological factor in vasospasm. It should be possible to identify patients in jeopardy from vasospasm and institute early preventive measures. [5].

Complications

Intracranial aneurysm complications

1)
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3)
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4)
Kurki MI, Gaál EI, Kettunen J, Lappalainen T, Menelaou A, Anttila V, van 't Hof FN, von Und Zu Fraunberg M, Helisalmi S, Hiltunen M, Lehto H, Laakso A, Kivisaari R, Koivisto T, Ronkainen A, Rinne J, Kiemeney LA, Vermeulen SH, Kaunisto MA, Eriksson JG, Aromaa A, Perola M, Lehtimäki T, Raitakari OT, Salomaa V, Gunel M, Dermitzakis ET, Ruigrok YM, Rinkel GJ, Niemelä M, Hernesniemi J, Ripatti S, de Bakker PI, Palotie A, Jääskeläinen JE. High risk population isolate reveals low frequency variants predisposing to intracranial aneurysms. PLoS Genet. 2014 Jan 30;10(1):e1004134. doi: 10.1371/journal.pgen.1004134. eCollection 2014 Jan. PubMed PMID: 24497844.

5)
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