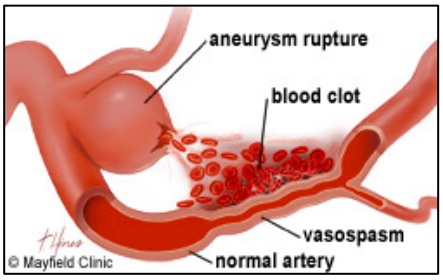
Prevention of Cerebral Vasospasm

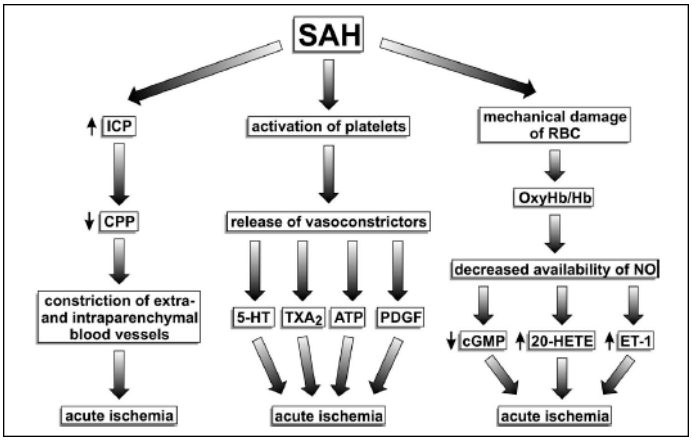
Anesthetic Pearls: Management of Cerebral Vasospasm Prevention



Cerebral vasospasm can occur in patients who suffer a traumatic brain injury (TBI), from a ruptured aneurysm, or hemorrhage from an arteriovenous malformation (AVM) or hemangioma. The common precipitating factor is the abnormal presence of blood on the outer surface of the blood vessel. Vasospasm is generally thought to occur only in arteries and not in smaller arterioles or capillaries or veins.

1. ***Angiographic* vasospasm** tends to be most readily detected at about 7 days after the subarachnoid hemorrhage (SAH), although it may be detected even as early as 3 days after the hemorrhage. It occurs in between 50-70% of all aneurysm patients depending on the time of angiography.

2. ***Clinical* vasospasm** occurs in approximately 33% of all patients suffering aneurysmal SAH.



The arterial narrowing that occurs in cerebral vasospasm is typically a transient or temporary event, naturally lasting from a few days up to 3 weeks. Despite the reversible nature of this condition, its occurrence may lead to brain ischemia / infaction or even death. The cascade of events leading to abnormal constriction of the artery begins with **oxyhemoglobin**, a breakdown product of red blood cells. Oxyhemoglobin, derived from the blood clot leads to the generation of oxygen-derived free-radicals such as **superoxide**. These toxic species damage cells throughout the adjacent blood vessel wall including endothelial cells, smooth muscle cells, adventitial fibroblasts, and nerve fibers. The vasomotor function of the artery is becomes disturbed and reacts by contracting in an abnormal manner. There is a known association between the severity of the hemorrhage and the occurrence / severity of cerebral vasospasm.

Medical management involves **Nimodipine** early and adherence where possible to the principles of **hyperdynamic (HHH) therapy**. Nimodipine is a calcium channel blocker; it dilates arteries by blocking the entry of calcium ions into vascular smooth muscle cells. It may also be neuroprotective by offering direct protection to brain neurons. **HHH *(hypervolemic-hypertensive-hemodilution)* therapy**, by changing the rheologic and hemodynamic profile of the blood is associated with improved blood flow within the brain. This form of therapy, however, is not without risks, particularly if the patient's aneurysm has not been surgically clipped, in which case HHH therapy can increase the risk of aneurysmal re-bleeding. Other methods used to emergently dilate or relax a vasospastic artery are based on using a catheter either to deliver a strong vasodilating agent, **Papaverine**, directly into the territory of the vasospastic artery in order to "pharmacologically dilate" the artery, or to physically wedge a balloon-tip catheter in the vasospastic artery itself and use the balloon (expanded from the catheter-tip) to "mechanically dilate" the artery (**mechanical angioplasty**). Papaverine therapy often works, however the effects are very short duration. Mechanical angioplasty also works, but the artery can rupture during angioplasty, and normal arterial function is never physiologically restored. Catheter-based techniques are reserved for severe vasospasm emergencies and optimal results require an experienced interventional neuroradiologist or endovascular neurosurgeon.

Surgical intervention is the most effective maneuver to prevent cerebral vasospasm by clipping the aneurysm early and removing as much of the subarachnoid blood products as possible (products known to trigger vasospasm). However, excessive mechanical manipulation of blood vessels intra-operatively can increase their risk of precipitating vasospasm.

On the **experimental** horizon, gene therapy is being explored as a potential treatment option for cerebral vasospasm. Here, an engineered vector carrying the gene for nitric oxide synthase (which produces nitric oxide which is a strong vasodilating molecule), is delivered into a vasospastic territory, with the intention being to dilate the artery by causing the local overproduction of nitric oxide. Another method is to directly infuse lots of nitric oxide-containing solution (a liquid nitric oxide donor compound) into brain circulation either via the traditional intravascular approach or via the perivascular (adventitial) approach. These experimental procedures continue to be evaluated and early results appear promising.