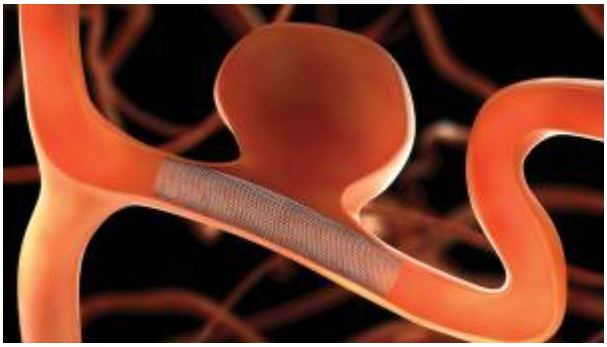
Pipeline™ Embolization Device (PED)



The Pipeline embolization device (PED, ev3 Endovascular, Plymouth, MN, USA) and Silk flow-diverting stent (Balt Extrusion, Montmorency, France) is a widely utilized flow diverter in the treatment of intracranial aneurysms, particularly those with unfavorable configurations.

Flow modification has caused a paradigm shift in the management of intracranial aneurysms. Since the FDA approval of the Pipeline Embolization Device (Medtronic, Dublin, Ireland) in 2011, it has grown to become the modality of choice for a range of carefully selected lesions, previously not amenable to conventional endovascular techniques. While the vast majority of flow diverter stents operate from within the parent artery (ie, endoluminal stents), providing a scaffold for endothelial cells growth at the aneurysmal neck while inducing intra-aneurysmal thrombosis, a smaller subset of endosaccular flow disruptors acts from within the lesions themselves [1].

It is a braided, platinum and nickel-cobalt chromium alloy, wire mesh cylindrical implanted device.

An aneurysm treated with a flow diverter is expected to involute over time, contrary to the immediate obliteration expected by surgical clipping or coiling. Yet, which aneurysms will respond to PED therapy and the time frame to expect full obliteration remains unclear [2].

Mechanism

It works by causing progressive flow redirection leading to thrombosis within the aneurysm.

Close to one-fifth of aneurysms, however, fail to occlude after PED placement.

The main mechanism of this stent is to divert the flow in the parent artery with reduction of inflow in the aneurysm leading to thrombosis.

Endothelial cell coverage along the Pipeline embolization device (PED) is one of two primary proposed mechanisms of action of the device, along with induction of intra-aneurysmal thrombosis [3].

Indications

see Pipeline Embolization Device Indications.

see Pipeline embolization device for posterior circulation aneurysm.

Complications

see Pipeline embolization device complications.

Systematic reviews

He te al. conducted a systematic review searching reports from multiple databases on PED use for intracranial aneurysms, and analyzed the influence of PED on the occlusion rate of different branching vessels, and the influence of the amount of PED on the occlusion rate of branching vessels by meta-analysis.

They searched the literature using PUBMED, Web of Science, and OVID databases until August 2023. Inclusion criteria were that the study used only PED, included at least 10 patients, and recorded branching vessels occlusion rates, mortality, and neurological complications.

Nine studies were analyzed consisting of 706 patients with 986 side branches. The results of the meta-analysis showed that application of more than one PED did not significantly elevate the rate of branching vessel occlusion compared to application of one PED (OR = 0.70; 95% CI: 0.34 to 1.43; P = 0.33). In the comparison of branching vessels occlusion rates in the anterior circulation, the anterior cerebral artery (ACA) had a significantly higher occlusion rate compared to the ophthalmic artery (OphA) (OR = 6.54; 95% CI: 3.05 to 14.01; P < 0.01), ACA also had a higher occlusion rate compared to the anterior choroidal artery (AchA) (OR = 15.44; 95% CI: 4.11 to 57.94 P < 0.01), ACA versus posterior communicating artery (PcomA) occlusion rate difference was not statistically significant (OR = 2.58; 95% CI: 0.63 to 12.82; P = 0.17), OphA versus AchA occlusion rate difference was not statistically significant (OR = 2.56; 95% CI: 0.89 to 7.38; P = 0.08), and the occlusion rate was significantly higher for PcomA compared to AchA (OR = 7.22; 95% CI: 2.49 to 20.95; P < 0.01) and lower for OphA compared to PcomA (OR = 0.33; 95% CI: 0.19 to 0.55; P < 0.01).

The meta-analysis shows that use of multiple PEDs did not significantly increase the occlusion rate of branching vessels, and the larger the diameter of branching vessels covered by PED, the higher the occlusion rate of branching vessels. However, the incidence of complications is low after branching vessels occlusion in anterior circulation, which is related to the collateral circulation compensation of the branching vessels [4].

Case series

see Pipeline embolization device case series.

Case reports

see Pipeline Embolization Device case reports.

1)
Dmytriw AA, Salem MM, Yang VXD, Krings T, Pereira VM, Moore JM, Thomas AJ. Endosaccular Flow Disruption: A New Frontier in Endovascular Aneurysm Management. Neurosurgery. 2020 Feb 1;86(2):170-181. doi: 10.1093/neuros/nyz017. PubMed PMID: 30834934.
2)
Gressot LV, Patel AJ, Srinivasan VM, Arthur A, Kan P, Duckworth EA. An intraoperative look at failure of flow diversion: when additional or alternative treatments should be considered. World Neurosurg. 2016 Jul 12. pii: S1878-8750(16)30519-8. doi: 10.1016/j.wneu.2016.06.131. [Epub ahead of print] PubMed PMID: 27422683.
3)
Ravindran K, DiStasio M, Laham R, Ogilvy CS, Thomas AJ, VanderLaan PA, Alturki AY. Histopathological demonstration of subacute endothelialization following aneurysm re-treatment with the Pipeline embolization device. World Neurosurg. 2018 Jul 18. pii: S1878-8750(18)31568-7. doi: 10.1016/j.wneu.2018.07.090. [Epub ahead of print] PubMed PMID: 30031197.
4)
He Y, Sun T, Han M, Wang D. Effect of the pipeline embolization device placement on branching vessels in anterior circulation: a systematic review and meta-analysis. Acta Neurochir (Wien). 2024 Jan 11;166(1):2. doi: 10.1007/s00701-024-05895-5. PMID: 38200390.