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| **#** | **Author(s) and Year** | **Study Title / Source** | **Research Purpose / Aim** | **Methodology** | **Key Findings** | **Limitations** |
| 1 | Nurminen et al., 2020 | Flow Diverter Stents for Internal Carotid Artery Aneurysms | To assess aneurysm occlusion rates, complications, and patient outcomes for ICA aneurysms treated with flow diverter stents. | Retrospective study of 62 patients (76 aneurysms) treated with flow diverters. Data from the Helsinki NeuroEndovascular database (2014–2019). Outcome measures: occlusion rates, ischemic/hemorrhagic complications, functional outcomes (mRS). | - Aneurysm occlusion rate at last follow-up: 89%.- Ischemic complications: 4.8%.- Functional outcomes improved (mRS score ≤2). | - Retrospective design with selection bias.- Small number of ruptured aneurysms (only 4 cases).- No systematic screening for asymptomatic complications. |
| 2 | Shehata et al., 2023 | Long-term Outcomes of Flow Diversion for Unruptured Intracranial Aneurysms: A Systematic Review and Meta-Analysis | To assess long-term (>1 year) safety and efficacy of flow diverters for unruptured intracranial aneurysms. | Systematic review and meta-analysis of 11 studies (1,186 patients). Data from PubMed, Web of Science, Embase, and SCOPUS (up to Feb 24, 2022). Outcome measures: occlusion rates, in-stent stenosis, retreatment rates, complications. | - Complete occlusion rates: 1 year (77%), 3 years (89.4%), 5 years (96%).- Retreatment rate: 5%.- In-stent stenosis: 4.8%.- No delayed aneurysm rupture; one case of delayed ischemic stroke. | - High heterogeneity across studies.- Lack of randomized controlled trials.- No direct comparison to other treatment modalities.- Follow-up durations varied. |
| 3 | Gupta et al. (2024) | Does Small Aneurysm Size (<10 mm) Predict Complete Occlusion After Flow Diversion? A Surpass Evolve Single-Center Study (Journal of Endovascular Therapy) | To assess the long-term safety and efficacy outcomes of the Surpass Evolve flow diverter (SEFD) in treating intracranial aneurysms and identify predictors of complete occlusion. | Retrospective review of 51 patients with 80 aneurysms treated with SEFD from 2020-2022; follow-ups at 6 months, 1 year, and 2 years. | Aneurysm size <10 mm predicted complete occlusion (88.8% at 2 years); SEFD had a favorable safety profile with 7.2% major complications. | Retrospective design, single-center study, small sample size, and loss to follow-up (8.7%). |
| 4 | Covell et al. (2024) | Transcirculation Approaches to Endovascular Flow Diversion of Intracranial Aneurysms: A Systematic Review With Technical Considerations (Operative Neurosurgery) | To review the use of transcirculation approaches in flow diversion for intracranial aneurysms, assessing safety, efficacy, and indications. | Systematic review of 12 studies involving 19 patients; analysis of aneurysm characteristics, procedural details, occlusion rates, and complications. | Transcirculation flow diversion achieved 84.6% success in occlusion; Pipeline Embolization Device (PED) was most used; 15.4% had intraoperative complications. | Small sample size, potential publication bias, high variability in procedures, and expert-dependent outcomes. |
| 5 | Richa Singh Chauhan et al. (2020) | Cavernous carotid artery large aneurysm treated with a new flow diverter – Xcalibur aneurysm occlusion device (Interventional Neuroradiology) | To report the first case of a symptomatic cavernous segment aneurysm treated with the Xcalibur Aneurysm Occlusion Device (AOD). | Case study of a 58-year-old female with a large, symptomatic, unruptured right cavernous ICA aneurysm, treated using the Xcalibur AOD. Follow-up at 3 and 6 months. | Complete aneurysm exclusion with symptom resolution at 6 months. Promising alternative to existing flow diverters. | Single case report; broader validation needed. Limited suitability for vessels <2.75mm. Potential conflict of interest disclosed. |
| 6 | T.P. Madaelil et al. (2017) | Flow Diversion in Ruptured Intracranial Aneurysms: A Meta-Analysis (American Journal of Neuroradiology) | To estimate angiographic occlusion rates and clinical outcomes in patients with ruptured intracranial aneurysms treated with flow-diverting devices. | Meta-analysis of 20 studies, including 126 cases of ruptured aneurysms treated with flow diversion. Statistical comparisons were made using the Fisher exact test. | 90% complete aneurysm occlusion. 81% favorable clinical outcomes. Aneurysms >7 mm had lower favorable outcomes. Aneurysms >2 cm had a higher risk of rerupture. | Reporting bias from case reports. Variability in treatment protocols. Small sample size in some subgroups. Inconsistent follow-up durations across studies. |
| 7 | Luqiong Jia et al. (2020) | Evaluating the Tubridge™ Flow Diverter for Large Cavernous Carotid Artery Aneurysms (Chinese Neurosurgical Journal) | To assess the safety and efficacy of the Tubridge™ Flow Diverter (TFD) in treating large cavernous carotid artery aneurysms (LCCAs, 10–25 mm). | Single-center, retrospective study (2013–2014). Seven patients treated with TFDs and coils. Angiographic and clinical follow-ups conducted over a median period of 73.3 months. | 100% favorable angiographic outcomes (O’Kelly–Marotta Scale C or D). No new neurological deficits. Six patients had an mRS score of 0. One patient had parent artery occlusion but remained asymptomatic. | Small sample size (only seven patients). Single-center, retrospective study. Lack of imaging data beyond symptom resolution. Larger, controlled trials needed. |
| 8 | Nguyen et al., 2024 | Sequential Flow Diversion After Nitinol Stent Placement for a Large, Matricidal Cavernous Internal Carotid Artery Aneurysm | To demonstrate the placement of sequential Surpass Evolve flow diverters within a Neuroform Atlas nitinol stent for treating a previously stented large ICA aneurysm. | Case study with a technical video documenting the treatment of a patient with a symptomatic cavernous ICA aneurysm, initially treated with a Neuroform Atlas stent, followed by sequential Surpass Evolve flow diverters. | - Successfully deployed sequential flow diverters.\n- Angiographic follow-up showed improved aneurysm occlusion.\n- Demonstrated feasibility of flow diversion in a previously stented aneurysm. | - Single-patient case study, limiting generalizability.\n- No long-term clinical outcome data.\n- Lack of comparative analysis with alternative treatments. |
| 9 | Lei et al., 2023 | Technical Advantages of a Novel Flow Diverter in Complex Flow Diversion: Patient Series | To evaluate the benefits of the Surpass Streamline flow diverter (SSFD) in managing complex aneurysm cases. | Retrospective case series analyzing 4 patients treated with SSFD for complex aneurysms, with follow-up imaging at 6 to 24 months. | - SSFD provided improved wall apposition and complete occlusion in challenging cases.\n- Unique properties (over-the-wire system, longer length, larger diameter) enhanced outcomes.\n- No major complications reported. | - Small sample size (4 cases).\n- Retrospective design without control group.\n- Limited long-term outcome assessment. |
| 10 | Sgreccia et al., 2019(Herthika) | Rare and Symptomatic Cavernous Donut-Shaped Aneurysm Treated by Flow Diverter Deployment | The article aims to describe a rare case of a cavernous donut-shaped aneurysm and its successful treatment using a flow-diverter (FD) stent. It also provides a literature review of similar cases to analyze different endovascular approaches. | A **case report** of a 62-year-old woman presenting with diplopia, left eyelid swelling, ptosis, and retroorbital pain due to a 25-mm left intracavernous aneurysm with a central thrombus.Diagnostic imaging included **CT angiography and digital subtraction angiography (DSA)** to confirm the aneurysm and its morphology. The patient underwent **endovascular treatment using an FD stent** to occlude the aneurysm, reduce the mass effect, and maintain patency of the internal carotid artery.Follow-ups at 6 and 12 months included **CT angiography and DSA** to assess aneurysm occlusion and arterial remodeling | **Complete occlusion of the aneurysm** was achieved within 12 months post-treatment. The patient experienced **full recovery from oculomotor palsy** and related symptoms. The study also reviewed 9 previous cases of donut-shaped aneurysms, analyzing treatment approaches and outcomes. | The study is a **single case report**, which limits the generalizability of findings.There is **no long-term follow-up beyond 12 months**, leaving uncertainties about potential recurrence or delayed complications. **Lack of a standardized treatment approach** due to the rarity of the condition, as different cases were managed based on individual physician expertise.The study **does not compare different treatment modalities systematically**, making it difficult to conclude the superiority of FD stents over other interventions |
| 11 | Liyong et al., 2022(Herthika) | Multiple Telescoping Flow Diverter Technique in Endovascular Treatment of a Giant Petrous and Cavernous Carotid Aneurysm | The article aims to present a case study on the use of the **multiple telescoping flow diverter (FD) technique** for treating a **giant petrous and cavernous carotid aneurysm**. The study also discusses the technical aspects and potential advantages of using the **Lattice flow diversion device (AccuMedical, Beijing, China)** in treating complex, long-segment aneurysms. | **Case Report**: A 24-year-old male presented with **headaches and left facial numbness**.**Imaging and Diagnosis**: MRI and angiography revealed a **giant thrombosed dissecting carotid aneurysm** involving the petrous and cavernous segments of the internal carotid artery.**Endovascular Treatment**: The **multiple telescoping FD technique** was employed to ensure full coverage of the aneurysm. A total of **five Lattice flow diverters** were deployed in a telescopic manner to reconstruct the artery.**Follow-up**: The patient was monitored for **six months post-procedure** using angiography. | The **procedure was successfully completed without complications**. The patient’s **neurological symptoms completely resolved** within three months.At **six months**, follow-up angiography showed **complete remodeling of the internal carotid artery** with no evidence of aneurysm opacification.The study highlights the **effectiveness of the multiple telescoping FD technique** in treating **long-segment, giant aneurysms**, ensuring optimal flow diversion and aneurysm exclusion. | **Single case study**: Findings may not be generalizable to a larger patient population.**Limited follow-up duration**: Long-term durability of the treatment remains uncertain.**Technical complexity**: The use of multiple telescoping flow diverters requires expertise and may not be feasible in all clinical settings.**Lack of comparative analysis**: The study does not compare this technique with other treatment options, such as single FD deployment or alternative endovascular approaches. |
| 12 | Kumaria et al., 2021(Herthika) | Successful treatment of giant cavernous carotid artery aneurysm in a child using a flow diverter stent | The article aims to present a rare case of a **giant cavernous carotid artery aneurysm in a pediatric patient** and its successful treatment using a **flow diverter (FD) stent**. It highlights the **angiographic characteristics, treatment approach, and clinical outcomes**, discussing the challenges of using FDs in children. | **Case Report**: An **8-year-old boy** presented with **double vision** (diplopia) two weeks after receiving intravenous antibiotics for **septic arthritis**. He had previously had **chickenpox**, but had otherwise been healthy.**Initial Imaging & Diagnosis**: MRI and CT angiography revealed a **19mm serpiginous aneurysm** in the **left cavernous internal carotid artery**, with a **narrow neck (4.5mm)** and **pressure erosion on the sphenoid bone and posterior clinoid process**.**Conservative Management**: The aneurysm was **initially monitored** since the symptoms resolved spontaneously.**Progression & Treatment**: By **age 12**, the aneurysm had grown to **26 × 21 × 22 mm**, prompting intervention.**Endovascular Procedure**: The patient was premedicated with **aspirin and clopidogrel**. **Cerebral angiography** confirmed aneurysm enlargement. A **Pipeline Flex (5 × 18 mm) flow diverter** was deployed across the aneurysm neck.**Post-procedure monitoring**: Antiplatelet therapy continued for **six months**, and aspirin was continued **long-term**.**Follow-up & Outcome**: At **age 15 (three years post-treatment)**, the patient was **clinically well**. MR angiography showed **complete thrombosis and shrinkage** of the aneurysm. The patient was **discharged from further follow-ups**. | **Successful treatment** of a rare pediatric **giant cavernous carotid aneurysm** using an FD stent.**Complete occlusion and shrinkage** of the aneurysm without complications.**Long-term resolution of symptoms** and no neurological deficits three years after treatment.The case highlights **FD stenting as a viable alternative** to **cerebral revascularization** in children. | **Single case study**: The findings may not be generalizable to all pediatric patients.**Unclear long-term durability**: While the patient remained well for **three years**, **long-term follow-up beyond adolescence** is missing.**Etiology uncertainty**: The aneurysm might have been caused by **post-septic arthritis or varicella vasculitis**, but this remains speculative.**Limited experience with FDs in children**: Given the **rarity of pediatric intracranial aneurysms**, standardized treatment protocols are lacking. |
| 13 | Vásconez Muñoz et al., 2024(Herthika) | Endovascular treatment of high-flow carotid-cavernous fistula secondary to rupture of a carotid-cavernous aneurysm post-flow diverter stent placement |  |  |  |  |
| 14 | Sila et al., 2021(Herthika) | Giant internal carotid aneurysm: endovascular parent artery occlusion after failed treatment using a flow diverter-case report | The article aims to present a case of a **giant internal carotid artery (ICA) aneurysm** that was **initially treated with a flow diverter (FD) stent but failed**, leading to **successful treatment with parent artery occlusion (PAO)**. The study highlights the **challenges of treating giant aneurysms**, the **limitations of flow diverters**, and the role of **balloon occlusion testing (BOT) with induced hypotension** before PAO. | **Case Report**: A **56-year-old woman** presented with **right-sided ptosis** due to **external oculomotor palsy**.**Imaging & Diagnosis**: MRI and CT angiography revealed a **30 mm cavernous ICA aneurysm**. Digital subtraction angiography (DSA) confirmed a **wide-necked giant aneurysm** with **significant contact to the parent vessel**.**Initial Treatment (Failed)**: A **Pipeline flow diverter stent** was deployed but failed to unfold correctly due to vessel curvature. Multiple attempts to reposition the stent were unsuccessful, leading to termination of the procedure.**Alternative Treatment – Parent Artery Occlusion (PAO)**: A **balloon occlusion test (BOT)** was conducted with **transcranial Doppler (TCD) monitoring**. The test showed **adequate collateral circulation**, but there was a **systolic flow drop** in the middle cerebral artery (MCA). A **hypotensive challenge during BOT** was performed to further assess collateral circulation.**Coiling of the aneurysm and PAO were then performed**.**Post-Treatment Monitoring**: The patient was placed on **dual antiplatelet therapy** (aspirin + clopidogrel) for 6 weeks, followed by lifelong aspirin. A **CT scan on Day 1** post-procedure showed no infarction. A **perfusion CT scan on Day 9** confirmed **normal blood flow to the right hemisphere**. The **oculomotor palsy resolved within 3 months**. | **Failure of flow diverter stenting** in treating the **giant cavernous ICA aneurysm**.**Successful treatment with PAO**, supported by thorough **BOT and hypotensive challenge**.**No neurological complications** after PAO.**Complete aneurysm occlusion** with no signs of infarction or ischemia. **Resolution of oculomotor palsy** over time | **Single case study**: The findings may not be generalizable to other patients.**Uncertainty in long-term outcomes**: While short-term results were good, the study does not discuss the **long-term durability of PAO**.**Risk of PAO**: While effective, PAO carries risks of **delayed ischemia or complications** in patients with inadequate collateral circulation.**Hypotensive challenge limitations**: The study supports using **induced hypotension during BOT**, but this technique is not universally accepted or standardized. |
| 16 | Fehrenback et al., 2022 | Management of Cavernous Carotid Artery Aneurysms: A Retrospective Single-Center Experience | Marked lack of evidence based clinical guidelines for CCA as new treatment options are developed. | **This study was based off retrospective data from the University Hospital in Leipzig Germany from Jan 1st 2014 to November 1st 2020. Identified 64 patients with CCA and reported on their respective therapeutic strategies and follow up. Patients were also analyzed based on recorded comorbidities (elevated blood pressure, diabetes mellitus, and nicotine consumption), PHASES score, aneurysm site, size and shape, therapeutic strategy, neurological deficits, and clinical follow-up.** | **53yrs mean age (86% female)****3.8 yr mean follow up time****22 pts found to have cranial nerve deficit, 50% showing a relief regardless of therapy****98% remained un ruptured****Larger PHASES score in symptomatic pts (mass effect)** | **Insufficient follow-up period (mean 3.8 years) to assess long-term outcomes****Single-center experience limiting generalizability****Retrospective design introducing potential selection bias****Small sample size (64 patients) limiting statistical power** |
| 17 | Wendl et al., 2016 | Direct carotid cavernous sinus fistulae: vessel reconstruction using flow-diverting implants | To retrospectively evaluate the use of flow diverters (FDs) for the endovascular treatment of direct carotid-cavernous sinus fistulae (diCCF).To assess the safety, effectiveness, and outcomes of FD placement alone or in combination with other endovascular techniques.To explore whether FDs offer advantages over traditional methods like detachable balloons, coils, and covered stents. | **14 consecutive patients from 2011 – 2015 who were diagnosed with diCCF (type A CCF) via clinical symptoms (e.g., chemosis, exophthalmos, visual impairment) and confirmed using digital subtraction angiography (DSA).****FD placement was performed in all patients.****Some patients also received covered stents, coils, or both.****Dual platelet antiaggregating therapy was administered to prevent thrombosis.****Treatment success was monitored via follow-up DSA and clinical evaluations at 3, 6, and 12 months, then annually.****Primary Outcomes:****Angiographic success: Complete occlusion or reduction of the shunt.****Clinical outcomes:** **Resolution or improvement of symptoms (e.g., ocular symptoms, cranial nerve deficits).** | **FD placement was successfully achieved in all 14 patients without intra-procedural complications.****FD alone: 5 patients.****FD + covered stents: 2 patients.****FD + coils: 7 patients.****3/14 cases (21%) achieved complete occlusion after the first session.****7/14 (50%) had minor residual shunting, and 4/14 (29%) showed significant reduction in shunt volume.****Some cases required additional coil occlusion or further FD placement in follow-up sessions.****10/14 patients (71%) were free of ocular symptoms at last follow-up.****2 patients had residual mild exophthalmos****No patient experienced worsening of preexisting or new symptoms.** | **Very small sample size (only 14 patients) severely limiting statistical significance****Retrospective design without a control group****Heterogeneous treatment approaches making it difficult to isolate flow diverter effects****Insufficient follow-up to detect long-term complications** |
| 18 | Tanweer et al., 2014 | Cavernous Carotid Aneurysms in the Era of Flow Diversion: A Need to Revisit Treatment Paradigms | To evaluate the efficacy and safety of flow diversion using the Pipeline Embolization Device (PED) in treating cavernous carotid aneurysms (CCAs).To determine whether current treatment paradigms for CCAs should be revised in light of newer, less invasive techniques.To compare institutional data with a systematic literature review on the morbidity and mortality associated with flow diversion for CCAs. | **Retrospective institutional study and systematic review of literature on PED treatment for CCAs.****Institutional Study****43 CCAs treated at New York University using PEDs.****Prospective data collection, but retrospective analysis.****Baseline demographics, clinical features, interventional data, and follow-up results recorded.****PED placement with standard endovascular technique.****Patients were pre-treated with antiplatelet therapy (clopidogrel and aspirin).****Follow-up angiography at 6, 12, and 36 months to assess aneurysm occlusion.****Systematic Review****Studies including ≥5 patients treated with flow diversion for CCAs.****Follow-up ≥3 months with complication/mortality data.****MEDLINE (PubMed) and EMBASE databases searched for relevant articles up to April 2013. With the following outcome measures:****Complete or near-complete aneurysm occlusion.****Complication rates (major morbidity, mortality).****Visual outcomes in symptomatic patients.** | **43 CCAs in 41 patients.****57 ± 14.2 years. (84.1% female)****Presenting Symptoms:****Visual disturbances (diplopia, visual field deficits): 65.1%.****Headaches: 16.3%.****Incidental findings: 9.3%.****Aneurysm Characteristics:****Large aneurysms (10–25 mm): 53.5%.****Giant aneurysms (>25 mm): 46.5%.****Mean aneurysm size: 24.3 ± 9.7 mm.****Mean neck size: 13.6 ± 11.6 mm.****All PEDs were successfully deployed without major technical complications.****Complete or near-complete aneurysm occlusion:****6 months: 81.4%.****12 months: 89.7%.****36 months: 100%.****No PED migration or aneurysm expansion was observed.****In-stent stenosis (>50% narrowing) was detected in 4 patients (9.3%), all asymptomatic.****Mortality rate: 0%.****Major neurologic complication rate: 2.3% (1 patient had an intraoperative subarachnoid hemorrhage).****Transient neurologic deficits: 3 cases.****Neuro-ophthalmologic improvements:****84.2% of symptomatic patients had visual improvement.****No cases of visual worsening.****1 case of carotid-cavernous fistula (CCF) detected at 6-month follow-up.** | **Limited sample size (43 CCAs) from a single institution****Gender imbalance (84.1% female) restricting generalizability****Retrospective analysis introducing potential selection bias****Lack of direct comparison with alternative treatment modalities** |