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Case Report

# Covered stent as an Optional Endovascular Approach to Treat Direct Carotid-cavernous Fistula: A Case Report

Annisa Bunga Nafara[1], Ahmad Sulaiman Alwahdy[2], Elsa Primadona Sulfana Putri[1]

[1] Department of General Medicine, Fatmawati Hospital, Jakarta, Indonesia
[2] Department of Neurology, Fatmawati Hospital, Jakarta, Indonesia

**Corresponding Author:**
Annisa Bunga Nafara
Department of General Medicine,
Fatmawati Hospital, Jakarta, Indonesia
Email: annisabunga.gp@gmail.com

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**Introduction:** The use of covered stents has emerged as a treatment option for direct Carotid Cavernous Fistula (dCCF). However, it has not been routinely adopted in Indonesia. We report the first case in Indonesia of direct traumatic CCF successfully treated with a covered stent as the first-line endovascular therapy. **Case:** A 21-year-old woman with blurred vision, diplopia and swelling in the right eye, cranial nerves III and VI palsy with a history of traumatic fall two months prior. Digital Subtraction Angiography confirmed the presence of a right-sided direct carotid-cavernous fistula. Embolization was performed using a 3.5x16 mm Bentley covered stent at the fistula site. Direct embolization confirmed a type A right CCF resulted in complete obliteration and previous complaints were significantly reduced. **Conclusion:** Endovascular therapy with covered stents offers a promising treatment option for CCF, providing vessel patency and effective fistula occlusion. But the risk of complications should be considered.

**Keywords:** Carotid-cavernous fistula, Covered stent, Embolization, Endovascular

**Highlights**

- Direct CCF often mimics neuro-ophthalmic disorders, causing delayed diagnosis.
- Covered stent is effective as a primary endovascular option for dCCF.
- Risks of covered stent placement are stenosis, thrombosis and branch occlusion.

## Introduction

Carotid-cavernous fistula (CCF) is an abnormal shunt between the cavernous sinus and the carotid artery, with an estimated incidence of 0.37 cases per 100,000 annually (95% CI 0.20–0.68).[1] This condition most commonly affects young adult males and typically presents as a direct, high-flow fistula.[2] CCFs can be classified based on etiology (spontaneous or traumatic), hemodynamic characteristics (high-flow or low-flow), angioarchitecture, and arterial supply.[3]

Endovascular occlusion using detachable balloons or coil embolization remains the standard treatment for most cases of direct CCF (dCCF).[4] However, the limitations of Indonesia's national health coverage make decision-making for coil embolization challenging. Covered stents have been used in complex CCF cases, particularly when balloon or coil techniques are unsuccessful or unsuitable. Nonetheless, their role as a first-line treatment remains a subject of debate.[5]

To the best of our knowledge, this is the first report of using a covered stent as a first-line therapy for CCF in Indonesia, highlighting procedural nuances and device feasibility in resource-variable settings. We present a case of traumatic dCCF successfully managed with a covered stent as the initial endovascular treatment. This case demonstrates the feasibility and safety of covered stents in managing traumatic dCCF and supports their consideration as a viable endovascular option.

## Case

A 21-year-old woman presented with blurred vision and worsening swelling of the right eye for two weeks. She also reported intermittent headaches, progressive right eye proptosis, diplopia, and a pulsatile sensation radiating to her ear. Two months earlier, she had fallen from a height of five meters, landing on her forehead. A skull X-ray at the previous hospital revealed a mandibular fracture. On examination, the patient's right eye visual acuity was 5/50, improving to 5/10 with spherical dioptric correction, while the left eye was 5/15, improving to 5/5 with correction. Intraocular pressure was elevated in the right eye (38 mmHg) and normal in the left (20 mmHg). The right eye exhibited proptosis, an audible orbital bruit, conjunctival and ciliary injection, corkscrew-shaped episcleral vessels, and limited ocular movement in all directions except downward. Ptosis was also present, indicating paresis of the right oculomotor (CN III) and abducens (CN VI) nerves. The left eye appeared normal.

She was initially diagnosed with secondary glaucoma of the right eye and received topical treatment (Acetazolamide 250 mg twice daily, Timolol 5 mg twice daily, Latanoprost eye drop, and Sodium Hyaluronate 1 mg six times daily) for four weeks, before referred to the neurology clinic due to suspected CCF.

Magnetic Resonance Imaging (MRI) revealed retroorbital fat thickening and edema of the right extraocular rectus muscles, resulting in proptosis and dilation of right cavernous sinus (Figure 1). Coronal view of Magnetic Resonance Angiography (MRA) showed the presence of a right dCCF originating from the cavernous segment of the internal carotid artery (ICA) (Figure 2). The Digital Subtraction Angiography (DSA) confirmed the diagnosis of a right-sided Barrow type A dCCF (Figure 3).

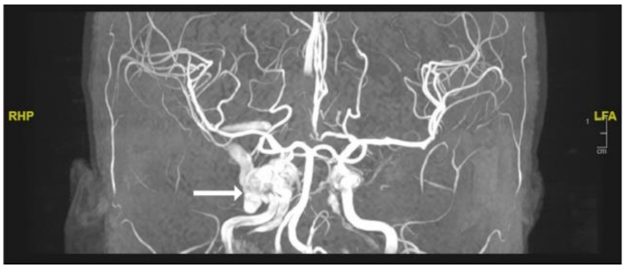

Figure 2. Coronal brain MRA showing a right dCCF originating from the right ICA (white arrow).

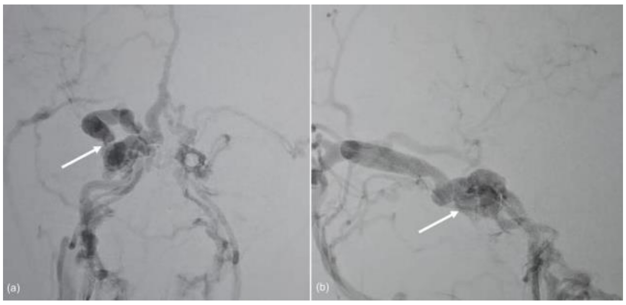

Figure 3. DSA image demonstrating contrast flow into the dilated cavernous sinus, indicating a fistula between the petro-cavernous segment and the right ICA, confirming a right dCCF (white arrow).

Figure 4. Cerebral angiogram taken during covered stent placement. (a) The covered stent was newly placed at the fistula point of the ICA, with residual endoleak visible. (b) DSA performed 15 minutes later demonstrated complete obliteration with normal flow and a patent right ICA (white arrow). (c) Vaso CT of the petro-cavernous segment of the right ICA showed the stent well opposed to the vessel wall, without endoleak, adequately sealing the fistula point.

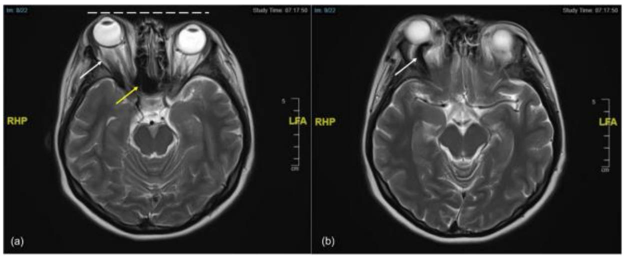

Figure 1. Brain MRI axial view. (a) Mild proptosis (dashed line), thickening of the right extraocular muscles (white arrow), and dilation of the right cavernous sinus (yellow arrow). (b) Dilatation and ectatic of the right superior ophthalmic vein (white arrow).

The embolization procedure was performed under general anesthesia, followed by systemic heparinization maintained at 2 to 2.5 the times baseline activated clotting time. Vascular access was obtained via the right femoral artery using an 8 Fr femoral sheath and a 5 Fr diagnostic vertebral catheter with a 0.035" hydrophilic angled guidewire. An 8 Fr, 90 cm Ballast long sheath (BALT USA LLC, Irvine, California, USA) was inserted into the petro-cavernous segment of the right ICA, followed by insertion of a 5 Fr Navien intermediate catheter (Medtronic, Minneapolis, Minnesota, USA) into the fistula site using a 0.014" Transcend microwire. Embolization was performed using a 3.5 × 16 mm Bentley covered stent (Bentley InnoMed GmbH, Hechingen, Baden-Württemberg, Germany) at the fistula location.

DSA revealed an endoleak just after the stent placement (Figure 4a). Balloon angioplasty was then performed from the distal to proximal stent segment using a 4 × 12 mm Sapphire NC balloon (OrbusNeich Medical, Shenzhen, China), slightly larger than the covered stent. Typical pressure of around 14 atmospheres (atm) was used in a case report to deploy a 3.5 mm BeGraft stent.

A follow-up DSA performed 15 minutes later showed no evidence of thromboembolism or contrast extravasation (Figure 4b). Embolization resulted in complete occlusion of the type A dCCF (Figure 4c). On the third day post-procedure, significant improvement was observed in proptosis, eyelid edema, conjunctival congestion, and diplopia, accompanied by partial recovery of paresis of the right cranial nerves III and VI (Figure 5).

Following the intervention, the patient was prescribed dual antiplatelet therapy (DAPT) for six months, followed by single antiplatelet therapy with aspirin. Regular ophthalmologic examinations, including intraocular pressure monitoring by a specialist, are recommended. Following the procedure, the patient underwent monthly follow-up evaluations in the clinic. Up to the eighth follow-up visit, no significant symptoms or complications were observed. A follow-up angiogram was scheduled for one year post-procedure or earlier if the symptoms recurred.

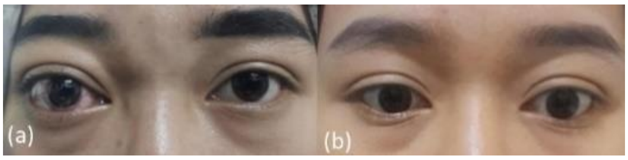


Figure 5. Clinical manifestation improvement in the eyes. (a). Swelling, proptosis dan conjuctiva ciliary injection of right eye 1 day before the procedure. (b) Significant improvement was observed three days after the procedure.

## Discussion

CCF is a rare complication of head trauma, particularly in skull base fractures, but it carries a significant risk of long-term disability. Approximately 0.3% of patients with craniofacial injuries develop a CCF.[6] The most common etiology (70–90%) is basal skull fracture.[7] According to arterial supply, Barrow classified CCFs into four groups: type A refers to a direct high-flow shunt between the intracavernous internal carotid artery (ICA) and the cavernous sinus, while types B, C, and D are indirect, low-flow fistulas supplied by dural branches of the ICA, external carotid artery (ECA), or both.[3] The present case was classified as a Barrow type A dCCF.

When the intracavernous segment of the ICA or its branches (or those of the ECA) are injured, arterial blood enters the cavernous sinus through the fistula. This increased pressure causes dilation of the superior and inferior ophthalmic veins (SOV and IOV), leading to ocular symptoms such as conjunctival congestion, edema, exophthalmos, and elevated intraocular pressure. Retinal ischemia and vision loss may occur due to reduced perfusion of the ophthalmic artery. Elevated intracavernous pressure can also compress surrounding structures, including cranial nerves III, IV, V, and VI, resulting in ophthalmoplegia.[8]

Because its manifestations can mimic other conditions—including Graves' ophthalmopathy,[9] ocular myasthenia,[10] conjunctivitis, primary glaucoma, idiopathic CN IV palsy, sinus headache, or migraine—diagnosis is often delayed, typically ranging from six weeks to nine months (median, seven weeks).[1] MRI/MRA and digital subtraction angiography (DSA) are crucial for establishing a definitive diagnosis and selecting the appropriate treatment. Imaging modalities used for diagnosing CCF include Doppler ultrasonography, computed tomography (CT), CT angiography (CTA), MRI, and MRA, with DSA remaining the gold standard for confirming the diagnosis and classification.[11,12]

Endovascular intervention is the first-line treatment for CCF, with a reported cure rate of 80%.[13] oil embolization is the most commonly used technique, accounting for approximately two-thirds of CCF cases (69.3%).[14] Covered stents are increasingly employed to maintain arteriovenous circulation patency, achieving complete occlusion rates of 90.9% in CCF treatment.[5,15] This technique preserves vessel patency, reconstructs the pathological segment, simplifies the intravascular procedure, and shortens intervention time.[16] Initially indicated for managing ruptured or perforated vessels, covered stents are now widely used in coronary, peripheral vascular, and carotid–cavernous interventions.[4,17]

In this case, we chose a covered stent approach because determining the exact number of coils needed for dCCF is often challenging, and more than three coils are typically required to achieve optimal obliteration. Additionally, Indonesia's National Health Insurance reimbursement scheme is highly limited, making it difficult to obtain approval for the required number of coils. In such situations, a covered stent can serve as a practical alternative in appropriately selected patients.'

Covered stents offer several advantages: they do not exert a mass effect on cranial nerves within the cavernous sinus, they reduce the risk of coil protrusion into the ICA lumen, and they allow for shorter intervention times, which is especially valuable in emergency situations.[17] However, complications such as endoleak (25.1%)[5], post-procedural ICA stenosis (18.6%)[5], and thrombotic events have been reported.[18] Chronic comorbidities such as hyperlipidemia and hypertension, along with inconsistent adherence to antiplatelet therapy, may further increase the stenosis risk.[19]

The use of intracranial covered stents remains limited due to several challenges, including the risk of occluding arterial branches, difficulty navigating tortuous vessels because of the device's large profile, limited size availability, thrombotic potential, and the need for continuous antiplatelet therapy.[17] Long-term angiographic follow-up is strongly recommended to monitor for complications and ensure procedural durability.[19]

The decision to use a covered stent for dCCF requires careful anatomical consideration. Owing to its relative rigidity, deployment is more suitable in straight vascular segments, whereas tortuous vessels may require intermediate catheter support. Although less adaptable than coils in complex anatomies, covered stents can provide immediate and definitive fistula occlusion in selected cases.

Endoleak management depends on its classification as direct or indirect. Direct endoleaks pose a risk of rapid aneurysm enlargement and rupture due to direct arterial pressure and therefore require prompt repair. Immediate management typically involves balloon angioplasty using a semi-compliant balloon slightly larger than the stent.[20] In this case, a direct endoleak occurred due to component separation and an inadequate seal, which was successfully managed with immediate balloon angioplasty.

The strength of this case lies in its novelty—it represents the first report from Indonesia documenting the successful use of a covered stent to treat a traumatic direct carotid–cavernous fistula. It provides detailed clinical, diagnostic, and procedural insights relevant to resource-variable settings. However, the study was limited by the absence of long-term follow-up data, preventing comprehensive evaluation of potential complications such as thrombosis or in-stent occlusion, and by the lack of direct comparison with other endovascular modalities.

## Conclusion

A traumatic CCF is a rare but potentially debilitating complication of head trauma. Its clinical presentation often mimics other ocular or neurological conditions, leading to delayed diagnosis. DSA remains the gold standard for diagnosis. Endovascular therapy, particularly with covered stents, is a promising treatment option for direct high-flow CCFs, providing vessel preservation and effective fistula occlusion. However, this approach carries the risk of complications, warranting careful patient selection and appropriate post-treatment follow-up.

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### Conflict of Interest
The authors declare no conflict of interest related to this case report.

### Patient consent for publication
Written informed consent was obtained from the patient for publication of the details and accompanying images in this report.

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### Author contribution
**Annisa Bunga Nafara:** Conceptualization, Methodology, Software, Validation, Formal Analysis, Investigation, Resource, Data Curation, Writing-Original Draft, Project Administration. **Ahmad Sulaiman Alwahdy:** Conceptualization, Validation, Formal Analysis, Investigation, Supervision, Data Curation, Writing-Review and Editing, Visualization. **Elsa Primadona Sulfana Putri:** Formal Analysis, Resource, Data Curation, Writing-Review and Editing.

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