Article published online: 2023-10-17

Failure of Reconstructive Technique to Repair a Giant Intracranial Fusiform Aneurysm of the Basilar Artery: Case Report and Literature Review in the Pediatric Population

Frank G. Solis[1] Mauro Toledo[1] Rosa L. Ecos[2]

[1] Neurological Surgery and Endovascular Neurosurgery, Instituto de Salud del Niño, San Borja, Lima, Peru
[2] Department of Vascular Neurology, Instituto Nacional de Ciencias Neurológicas, Lima, Peru

Address for correspondence Frank Solis, MD, Department of Neurosurgery, Endovascular Neurosurgeon. Instituto de Salud del Niño, San Borja, Lima 150130, Peru (e-mail: endovascularsolis@gmail.com).

Indian J Neurosurg 2024;13:150–155.

Abstract

Treatment of giant basilar aneurysm presents a major treatment challenge, especially in the pediatric population. Morbidity and mortality approach 80 and 30%, respectively. Both reconstructive and deconstructive techniques are associated with high rates of complete occlusion and good neurological outcomes. We report a 14-year-old male with a giant basilar trunk aneurysm treated with an endovascular approach. Clinical symptoms began following an ischemic stroke 2 weeks prior to admission. Endovascular treatment was performed through a reconstructive technique by single flow diverter device (FDD) in the basilar artery; however, this technique failed. At 1-year follow-up, without additional endovascular treatment, the mid-basilar artery and aneurysm were occluded, with vertebrobasilar flow maintained through collaterals from the right posterior communicating artery. We present a challenging management of giant basilar aneurysm in a pediatric patient experiencing a failure of FDD deployment; however, we highlight the importance of collateral flow development in progressive occlusions.

Keywords
- endovascular approach
- flow diverter device
- giant basilar aneurysm

Introduction

Posterior circulation aneurysms present a challenge for both endovascular and microsurgical treatment. Large intracranial aneurysm is defined as more than or equal to 10 mm, and giant aneurysm as more than or equal to 25mm in greatest diameter[1]; these aneurysms account for less than 5% of all intracranial aneurysms.[2,3] Mortality and morbidity rates vary across different settings from 10.6[4] to 30%[1,5,6] and 12[6] to 80%, respectively.[1,5] Most reports include few cases of giant vertebrobasilar (VB) aneurysm in the pediatric population.

Common clinical manifestations of posterior circulation aneurysms include headache, motor deficits and impaired consciousness, cranial nerve deficit, hydrocephalus, and other compressive symptoms due to space-occupying lesions, cerebral edema, subarachnoid hemorrhage, or less frequently ischemic stroke.[3,7] Serpentine aneurysms, a type of giant aneurysm with a "serpiginous-like" shape, and size more than 25mm and separate inflow and outflow from the parent artery, that is often partially thrombosed, represent a treatment challenge due to the high risk of occlusion of important branches of the VB system.[4] Serpentine arteries can occur in the anterior or posterior circulation,[7] and are

article published online
October 17, 2023

DOI https://doi.org/10.1055/s-0043-1776020.
ISSN 2277-954X.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

more frequent in people 60 years of age or older.[4] The natural history of unruptured VB aneurysm in pediatric population is not well documented. Data from adults' population reports a good prognosis in 97% of VB aneurysms at 2.9 years follow-up[5]; with unfavorable outcome associated with a high risk of rupture, rebleeding, and 24 to 33% mortality.[8] Factors associated with poor prognosis included enlargement of the aneurysm and size more than or equal to 10mm.[5]

Endovascular treatment is associated with high rates of long-term occlusion (87%), low recurrence (7%), and good neurologic outcome (84%); while 3% cases require retreatment.[4,9] Evidence supporting reconstructive and deconstructive treatment of large and giant basilar aneurysms in the pediatric population is limited to a few case series, as a result, most conclusions are based on the adult population. Reconstructive technique consists of maintaining the parent artery in contrast to deconstructive technique of occluding the parent artery. Reconstructive treatment includes single[10] or multiple[10–12] flow diverter device (FDD) deployment, FDD with coiling, with significant lower rates of complete occlusion (37–81%)[1,6] compared with 88% with deconstructive techniques.[4,9] Both techniques reported similar 86 to 92% rates of good neurologic outcome.[9] Aneurysm location is also a key factor associated with neurologic outcome; mid-distal basilar and holobasilar artery aneurysms have the lowest rate of poor neurologic outcome (18%), compared with 33 and 83% for proximal and VB junction artery aneurysms, respectively.[6] In the pediatric population, a direct occlusion of a parent artery (deconstructive approach) may be associated with worse outcome due to the acute interruption of blood flow to critical areas of the brainstem, while occlusion due to FDD may allow the posterior circulation to adapt and develop adequate collateral flow, with better long-term outcomes.[13]

In the following section, we present a clinical case of a giant aneurysm that failed to close following deployment of a single flow diverter. In addition, we performed a literature review of this pathology in the pediatric population using PubMed, Google Scholar, and Scopus. Key information from clinical cases of large and giant aneurysm of the VB arteries was collected for patients under 18 years of age. The local institutional ethics committee approved the report.

Illustrative Case

A 14-year-old male was admitted to the emergency room following sudden onset of quadriplegia and anarthria 2 weeks prior to admission. Cerebral tomography at admission demonstrated hypodensity in the left pons and a hyperdensity

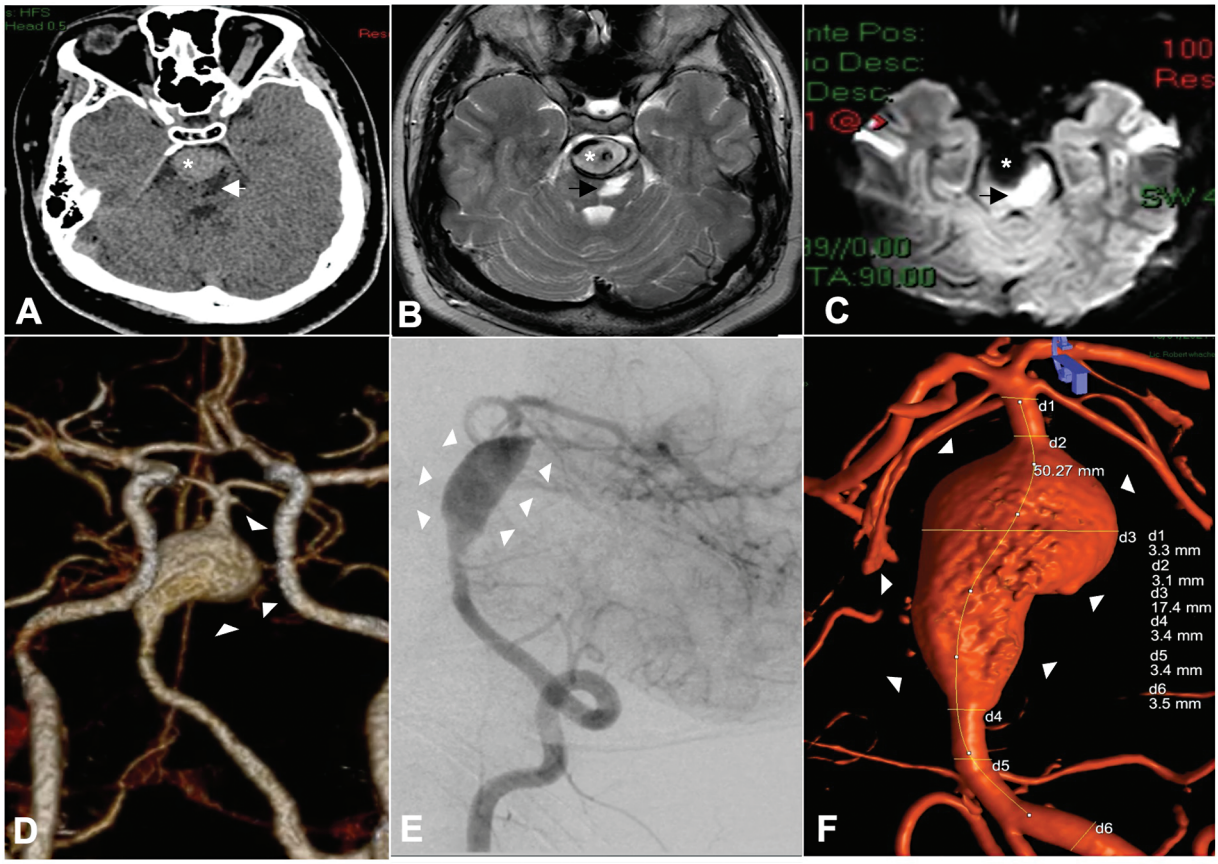

Fig. 1 (**A**) Admission cranial computed tomography scan demonstrating hypodensity in left base of the pons (white arrow) and a well-defined hyperdensity in prepontine cisternal (white asterisk); (**B** and **C**) Brain magnetic resonance imaging scan showing hyperdensity in T2 and diffusion-weighted imaging protocols at the level of the left pons (black arrows), and thrombosed basilar artery aneurysm (asterisk); (**D**) Cerebral tomography angiography showing a giant aneurysm of the basilar artery trunk (white head arrows); (**E** and **F**) Angiography in lateral view and three-dimensional reconstruction showing a giant 17 × 29mm basilar trunk aneurysm. No aneurysmal branches were detected (white arrowheads).

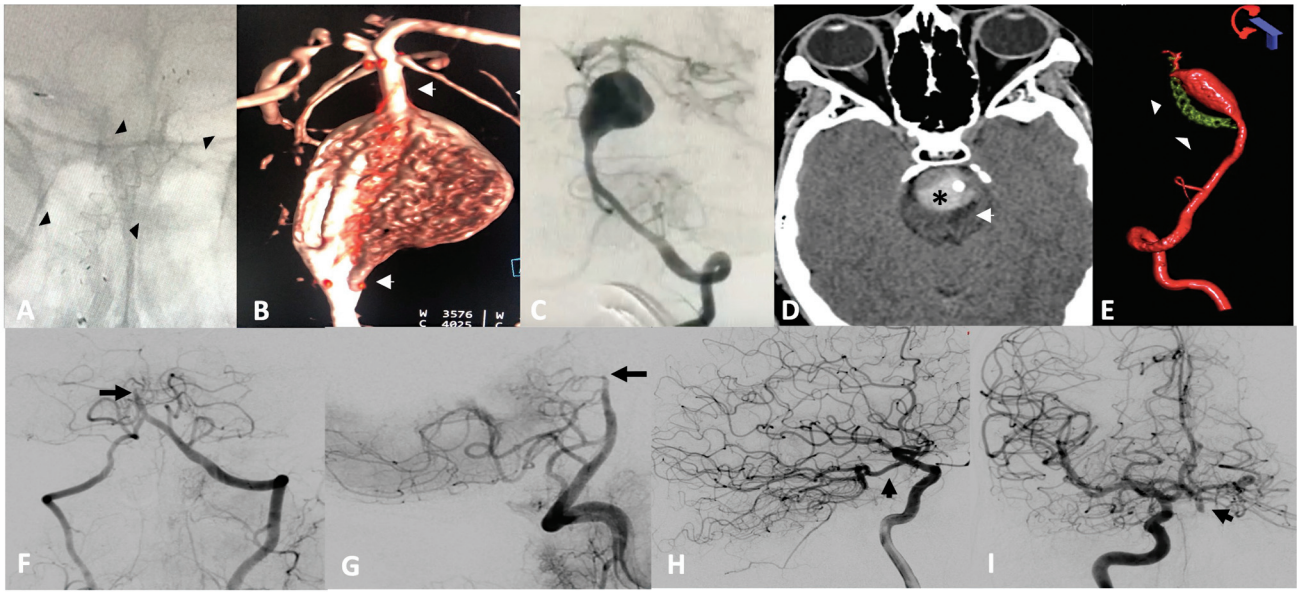

Fig. 2 (**A**) Angiography showing flow diverter (FD) deployment in the basilar artery (black arrowheads) at procedure time; (**B**) three-dimensional (3D) reconstruction angiography showing the flow diverter device (FDD) into the basilar artery lumen surrounded by the giant aneurysm at procedure time (white thin arrows); (**C**) two-dimensional angiography showing flow from the left vertebral artery to distal basilar artery immediately after FD deployment; (**D**) At 6 months follow-up, brain computed tomography scan showing stasis inside the aneurysm and FDD artifact (black asterisk), as well as an ischemic stroke sequalae at left base pons (white thin arrow); (**E**) At 6 months follow-up, 3D reconstruction angiography showing FDD displacement into the thrombosed aneurysm and diminished size of basilar artery aneurysm; (**F** and **G**) At 1-year follow-up, anteroposterior and lateral angiography demonstrated occlusion of the mid-basilar artery (black arrows); (**H** and **I**) lateral and anteroposterior angiography showing collateral flow through the right posterior communicant artery to both posterior cerebral artery, distal basilar, both superior cerebral artery, and branches (black arrows).

in the prepontine cistern (►**Fig. 1A**). Brain magnetic resonance imaging and computed tomography (CT) angiography confirmed a partially thrombosed giant aneurysm of the basilar artery trunk and a subacute cerebral ischemic stroke in the left pons (►**Fig. 1B–D**). Angiography with three-dimensional (3D) reconstruction was performed to plan management, demonstrating a partially thrombosed 29 × 17 mm aneurysm; no aneurysmal branches were detected (►**Fig. 1E, F**).

Dual antiplatelet therapy with aspirin 100 mg and clopidogrel 75 mg per day was initiated 4 weeks after symptoms began and a week prior to the procedure. Under Seldinger technique, using a 5 Fr femoral introducer and a 5 Fr guide catheter, we entered the left vertebral artery, guided by conventional two-dimensional and 3D angiography. A 27 Headway microcatheter and 0.014 microguide were then introduced into the right posterior cerebral artery (PCA); at this point a single 4038 FRED flow diverter was deployed using conventional technique from the superior cerebellar artery (SCA) to the anteroinferior cerebellar artery (AICA) along the basilar artery; the deployment and procedure were performed without complications (►**Fig. 2A–C**). The deployment of a unique 4038 FRED flow diverter was performed based on the availability of resources and the urgent need for treatment. At 3 and 5 months follow-up, there were no clinical or radiologic complications, motor and speech function recovery were excellent, with only mild impairment of left leg strength, reflecting a modified Rankin scale score of 1. Unfortunately, at 6 months follow-up, the patient presented with headache and mild quadriplegia. Brain CT did not show a recurrent stroke; nevertheless, angiography showed a displacement of the FDD into the thrombosed aneurysm sac and persistent aneurysm (►**Fig. 2D, E**). Medical treatment was performed with complete recovery of prior status. A second endovascular approach was planned to deploy a second FDD or distal basilar trapping next to the aneurysm within the following 6 months. The 1-year angiography follow-up showed occlusion of the mid-basilar artery and aneurysm (►**Fig. 2F, G**). Collaterals maintained the PCAs, distal basilar artery, and both SCA flow through the right posterior communicating artery; similarly, both AICA flow were preserved through the proximal basilar artery (►**Fig. 2H, I**). The patient remained with excellent neurologic function at 2-year clinical follow-up.

Discussion

We present a challenging management of a giant basilar aneurysm in a pediatric patient treated through an endovascular approach, which failed initial FDD reconstruction. There are few reports of treatment of giant basilar artery in the pediatric population. In our literature review, we identified 22 cases of giant VB aneurysm in the pediatric population (►**Table 1**). Our report of a 14-year old male is similar to the mean age of 11 years (range: 6–17 years); there was no predominant sex reported. This is the first report of ischemic stroke and compressive symptoms as a clinical presentation, differing from the more common

Table 1 Literature review of patients, aneurysm characteristics, and treatment details of large and giant vertebrobasilar aneurysms under 18-year-old population

Author, year	Case	Age, sex	Clinical presentation	Aneurysm characteristics			Treatment	Complications	Follow-up				
				Location	Type	Diameter (mm)			Time[b]	Occlusion grade	Parent artery	Branches	mRS
Kant et al, 2023[13]	1	10, M	Subarachnoid hemorrhage	Distal BA	Dissecting	32 × 12 × 20	Coiling occlusion of VA feeder	Ischemic stroke	12	Complete	Occluded	Patent	0
Wang et al, 2022[12]	2	8, F	Rebleeding	Distal BA	ND	27.4	2 FDs	No	12	Complete	Patent	Occluded	0
Ge et al, 2022[1]	3	17, M	Compressive symptom	Proximal BA	Fusiform	23	1 FD	No	19	Complete	ND	ND	0
	4	17, F	Headache	Proximal BA	Fusiform	30	3 FDs with VA occlusion	No	8	Complete	ND	ND	0
	5	12, M	Headache	Distal BA	Fusiform	33	4 FDs	Ischemic stroke, delayed ruptured aneurysm	–	–	–	–	6
	6	8, F	Headache	Proximal BA	Fusiform	26	2 FDs plus coiling and VA occlusion	No	12	Complete	ND	ND	0
	7	8, M	Compressive symptom	Proximal BA	Fusiform	26	2 FDs plus coiling and VA occlusion	Worsening mass effect	6	Complete	ND	ND	0
Jia et al, 2020[11]	8	ND[a], F	Persistent headache	VBJ	Dissecting	ND	3 FDs	No	4	Complete	Patent	Patent	0
Zhou et al, 2020[10]	9	8, F	Headache	BA	ND	17.6	2 FDs	No	36	Complete	ND	ND	0
	10	11, F	Headache	LVA	ND	25.7	1 FD	Occlusion RVA	30	Complete	ND	ND	0
	11	10, M	Headache	BA	ND	29.6	2 FDs	No	3	Complete	ND	ND	0
	12	12, M	Headache	BA	Fusiform	28.6	4 FDs	Brainstem infarction	–	No	–	–	6
	13	17, M	Headache	VBJ	Dissecting	27.5	2 FDs	Stent retraction	3	Complete	Patent	Patent	0
Li et al, 2020[3]	14	12, M	Headache	BA	No, saccular	25.3	4 FDs	No	–	–	–	–	6
	15	11, M	Headache	BA	Dissecting	30.3	Internal trapping	No	5	Complete	Occluded	ND	1
	16	6, F	Compressive symptom	VA	Dissecting	28.9	Internal trapping	No	6	Partial	ND	ND	3
	17	12, F	Compressive symptom	BA	Dissecting	34.2	Internal trapping	No	5	Partial	ND	ND	5
	18	11, F	Headache	VA	Dissecting	25.6	1 FD plus coiling	No	7	Complete	ND	ND	1
	19	10, M	Compressive symptom	VBJ	Dissecting	28.3	1 FD plus coiling, occlusion VA contralateral	No	6	Complete	ND	ND	3

(*Continued*)

Table 1 (*Continued*)

Author, year	Case	Age, sex	Clinical presentation	Aneurysm characteristics			Treatment	Complications	Follow-up				
				Location	Type	Diameter (mm)			Time[b]	Occlusion grade	Parent artery	Branches	mRS
Limaye et al, 2012[14]	20	16, M	Headache	BA	ND	ND[c]	1 FD	No	6	ND	ND	ND	ND[d]
	21	13, F	Headache, left hemiparesis	BA	ND	ND[c]	1 FD	Brainstem infarction (Locked-in syndrome)	6	ND	ND	Occluded	5
	22	16, M	Headache, SAH	VA	ND	ND[c]	Vertebral artery occlusion	No	6	ND	ND	ND	ND[d]
Our case	23	14, M	Ischemic stroke and mass effect	BA	Fusiform	29 × 17	1 FDD	No	12	Complete	Occluded	Patent	1

Abbreviations: BA, basilar artery; FD, flow diverter; LVA, left vertebral artery; mRS, modified Rankin scale; ND, not described; RVA, right vertebral artery; SAH, subarachnoid hemorrhage; VBJ, vertebrobasilar junction.
[a]Pediatric patient, specific age not described.
[b]Time in months.
[c]Giant aneurysm report.
[d]Reported as a good outcome.

headache (67%) and compressive symptoms (22%) reported in the case series reviewed. Our patient's aneurysm location on the basilar trunk is concordant with case reports (31% of cases), followed by the proximal basilar artery in 21%. The aneurysm type was fusiform, and a traumatic event was not associated with the aneurysm formation in our patient. In the case series, 40% reported fusiform aneurysm; however, the most frequent was aneurysm associated with dissection in 53% of cases (►**Table 1**).

Advantages of FDDs include decreasing the aneurysm volume and mass effect[4]; therefore, we chose to deploy a single FDD, which was also the procedure of choice in 53% of pediatric patients in the series reviewed. Of note, placement of a second FDD was required in 42% of patients. Other techniques reported in the series included FD with coiling and vertebral artery occlusion, as well as trapping of the aneurysm in approximately 30% of the cases. In our patient, we avoided these techniques given the possible increased mass effect associated with coiling of a giant aneurysm and possible branch occlusion leading to worsening in neurological condition.[10] No complication was reported during the procedure or with FDD deployment, differing from 23[6] to 31% of complications reported in the reported cases (►**Table 1**). The most frequent reported complication was ischemic stroke, similar to reports in adult patients, with a frequency of 7.7 to 100%.[3,14]

Complications in our patient that occurred at 6 months follow-up were likely due to the mass effect of the partially thrombosed aneurysm. Given displacement of the FDD from the original deployment site, we planned to perform a second endovascular approach due to the partial occlusion; need for retreatment was reported in 5 to 12.5% of patients.[3,6]

We performed a longer angiography follow-up time of 1-year than the median follow-up time of 6.5 months in the series reports. A complete occlusion of the aneurysm was observed, similar to 82% reported in the series; only two cases did not report occlusion grade of treated aneurysms.[1,3] Our patient had an excellent recovery with a very mild disability in concordance with 57% good recovery in the series reports, although the series noted a poor prognosis in 30% and 15% mortality rate. All mortality cases occurred in patients who underwent deployment of 4 FDDs[1,3,10] (►**Table 1**).

Our decision to deploy only one FDD was based on the initial in-flow aneurysm that would be covered by the FDD wires, the potential increased risk of parent artery occlusion with use of additional devices, and limited supplies to treat the aneurysm at that moment. The initial reconstruction choice to treat the giant basilar aneurysm using a single FDD failed to maintain the parent artery, and we believe it promoted the progressive mid-basilar trunk occlusion allowing collaterals to adapt and maintain VB flow, without branch occlusion or neurological complications.

Lessons

We present a challenging case of giant basilar aneurysm management in a pediatric patient who experienced a failure

of the initial FDD deployment; however, a complete occlusion of the aneurysm was obtained without additional endovascular treatment. The goal of progressive occlusion, with development of collateral blood flow to vital areas of the brainstem, may play a key role in influencing management of giant basilar aneurysms.

Authors' Contribution

F.S. and M.T. contributed to data collection, conceptualization, and manuscript drafting. RE helped in conceptualization, manuscript drafting, image preparation, and technical and manuscript review.

Conflict of Interest

None declared.

Acknowledgment

We would like thank Dr. Joe Zunt for proofreading the article, writing assistance, and feedback.

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