



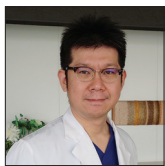
Case Report

# PulseRider “jack-up” technique for wide-necked basilar tip aneurysms that incorporate parent arteries: A technical note

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Received : 31 October 2022  
Accepted : 23 December 2022  
Published : 13 January 2023

DOI  
10.25259/SNI\_998\_2022

Quick Response Code:



## ABSTRACT

**Background:** Treatment of intracranial wide-necked bifurcation aneurysms remains challenging. We report a novel PulseRider “jack-up” technique for the treatment of wide-necked basilar tip aneurysms.

**Case Description:** We performed coil embolization in three patients with an unruptured wide-necked basilar tip aneurysm. Aneurysm neck diameters ranged between 7.6 and 11 mm and dome-to-neck ratios ranged from 1.0 to 1.15. All three aneurysms were very shallow with aspect ratios of 0.51–0.69 and incorporated both posterior cerebral arteries into the aneurysm wall. Because each was difficult to embolize using the standard PulseRider procedure, the PulseRider was deployed more proximally than usual and a coil frame constructed above it. Then, the coil was pushed or “jacked up” into the aneurysm with the PulseRider. Adequate embolization was achieved in all three patients.

**Conclusion:** Coil embolization using the PulseRider jack-up technique is effective for treatment of wide-necked basilar tip aneurysms that incorporate parent arteries.

**Keywords:** Aspect ratio, Balloon assist technique, Stent assist coil embolization, Y-stenting

## INTRODUCTION

Treatment of wide-necked bifurcation cerebral aneurysms in which the parent artery is incorporated into the aneurysm remains challenging. Treatment options include double catheter coil embolization, balloon-assisted coiling, and several stent-assisted coiling techniques, including Y- and T-stenting.<sup>[1,4,7]</sup> The PulseRider (Cerenovus, New Brunswick, NJ, USA) is a recently introduced self-expanding neck-bridging device designed for treating wide-necked bifurcation aneurysms. With the PulseRider, the parent artery is protected by deploying two T- or Y-shaped leaflets at the neck of the aneurysm to provide a scaffold for coil placement. In a meta-analysis of wide-necked aneurysms treated with PulseRider, adequate occlusion was achieved immediately after treatment in 90% of cases.<sup>[5]</sup> The standard procedure for PulseRider-assisted coil embolization involves first deploying the PulseRider at the aneurysm neck, guiding a microcatheter into the aneurysm, and then embolizing it using coils; the PulseRider is detached as the final step.

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PulseRider leaflets can be deployed in three positions: (1) an intra-aneurysmal position with both leaflets within the aneurysm, (2) an extra-aneurysmal position with both leaflets outside the aneurysm but within the parent artery, and (3) a hybrid position with one leaflet within the aneurysm and the other within the parent artery.<sup>[6]</sup>

We recently treated three patients with a wide-necked shallow basilar tip aneurysm that was not amenable to treatment using the standard PulseRider procedure. In all three, the parent artery itself was dilated and both posterior cerebral arteries (PCAs) or superior cerebellar arteries (SCAs) were incorporated into the aneurysm wall. The dome-to-neck and aspect ratios were also low in each aneurysm. Placing the PulseRider in the aneurysm neck in the standard fashion left a large space uncovered, which allowed deviation and migration of coil loops into the parent artery, even with small coils and after adjusting the PulseRider position. With the “jack-up” technique, the PulseRider is deployed more proximally than usual, a coil frame is constructed above it, and the coil is jacked up into the aneurysm later using the PulseRider. Using this technique achieved successful embolization in all three patients. To the best of our knowledge, neither this technique nor similar ones have been previously reported. Here, we report our experience and describe several technical tips.

## METHODS

Three patients with an unruptured wide-necked basilar tip aneurysm underwent endovascular treatment. Aneurysm measurements were performed using three-dimensional rotational angiography. Dome-to-neck and aspect ratios were calculated. Dual antiplatelet therapy (aspirin 100 mg/day and clopidogrel 75 mg/day) was initiated at least 1 week before the treatment. Platelet function was evaluated using the VerifyNow aspirin reaction unit (ARU) and P2Y<sub>12</sub> reaction unit (PRU) assays (Werfen, Bedford, MA, USA). Treatment was performed under general anesthesia. Patients were heparinized to achieve an activated clotting time (ACT) of 200–300 s. A 90 cm 5-Fr guiding catheter (Fubuki Dilator Kit; Asahi Intecc Medical, Aichi, Japan) was placed through the femoral artery to the vertebral artery in parallel with Prowler Select Plus (Cerenovus) and Excelsior SL10 (Stryker Neurovascular, Fremont, CA, USA) microcatheters. A 120 cm Guidepost (Tokai Medical Products, Inc., Aichi, Japan) was used as an intermediate catheter for the Prowler Select Plus as needed.

We first attempted coil embolization using the standard PulseRider procedure. The PulseRider was deployed through the Prowler Select Plus at the standard location in the aneurysm neck [Figure 1a]. Then, the SL10 was guided into the aneurysm to insert a coil. However, in each case, the coil deviated into the parent artery and could not be placed within the aneurysm; therefore, we attempted the jack-up technique.

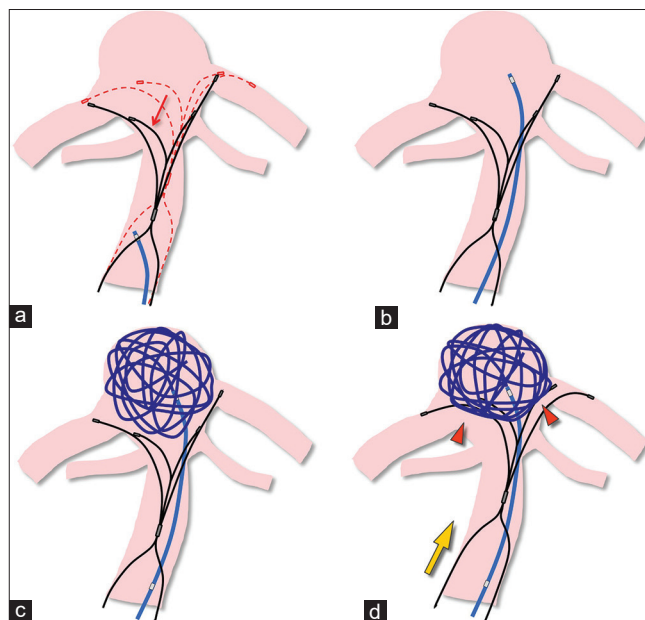
The SL10 and PulseRider were temporarily withdrawn proximally into the parent artery [Figure 1a] and the SL10 was reinserted into the aneurysm [Figure 1b]. A slightly undersized coil was inserted through the SL10 to create a spherical frame above the PulseRider utilizing the three-dimensional memory capability of the coil itself [Figure 1c]. Care was taken to ensure that the coil loop did not sit within the aneurysm and protruded below the PulseRider. The coil frame within the parent artery was then advanced or “jacked up” into the aneurysm by advancing the PulseRider, which was protecting the parent artery [Figure 1d]. Additional coils were then placed until adequate embolization was achieved. Then, the PulseRider was detached.

## CASE DESCRIPTION

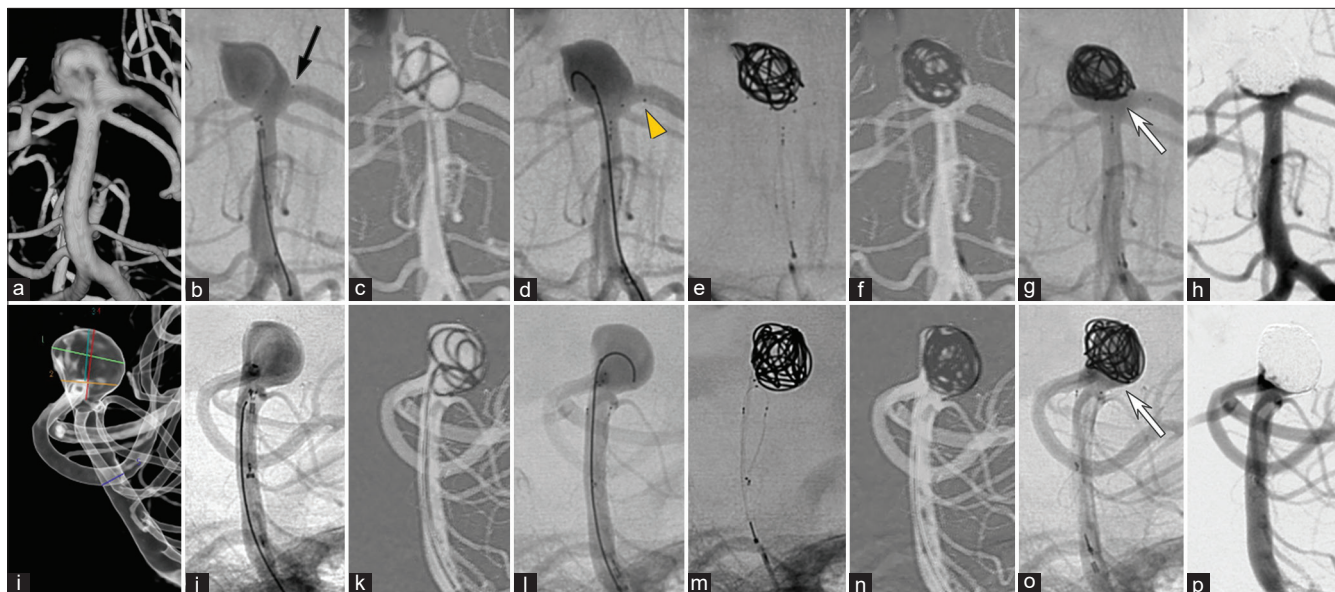
### Case 1

A 76-year-old woman with an incidental unruptured basilar tip aneurysm that enlarged during follow-up underwent endovascular treatment. Aspirin and clopidogrel were started 1 week before. The ARU and PRU were 392 and 135, respectively, at 2 days before the treatment.

On angiography, both PCAs were incorporated into the aneurysm wall and bifurcated laterally [Figures 2a and i]. Aneurysm measurements were as follows: diameter, 9.6 mm; neck, 8.3 mm; and height, 6.6 mm. Dome-to-neck and



**Figure 1:** With the PulseRider jack-up technique, (a) the PulseRider is temporarily positioned lower than usual (red arrow). The dotted lines indicate the typical position. (b) A microcatheter is then guided into the aneurysm for placement of coils. (c) A three-dimensional frame is created using the coil itself. (d) The PulseRider is advanced (yellow arrow) to pack the coil mass (arrowheads) into the aneurysm and then detached after coil embolization is completed.



**Figure 2:** (a-p) Angiography images of the basilar tip aneurysm in case 1. Panels are described in detail in the text. The black arrow indicates the PulseRider deployed in the normal position. The yellow arrowhead indicates the device position after partial proximal withdrawal. The white arrows indicate the coil mass “jacked up” into the aneurysm.

aspect ratios were 1.15 and 0.69, respectively. A PulseRider (10T/3.5–4.5) was deployed in the extra-aneurysmal position, with the leaflets inside each PCA [Figures 2b and j]. An Axiom Prime Frame 8 mm × 30 cm (Medtronic, Minneapolis, MN, USA) was inserted but deviated from the posterior space of the aneurysm [Figures 2c and k]. The PulseRider was temporarily withdrawn [Figures 2d and l] and the coil reinserted to create a spherical frame above it [Figures 2e, f, m, and n]. Then, the PulseRider was advanced to jack up the deviated coil [Figure 2g]. In the lateral view, the underside of the coil frame was pushed up [Figure 2o]. A total of 26 coils were added and successful embolization was achieved [Figures 2h and p]. ACT was 141 s before the procedure and 254–336 s during it.

After the procedure, the patient complained of mild diplopia. Diffusion-weighted magnetic resonance imaging on the next day showed a high-signal area in the left paramedian medulla oblongata. Magnetic resonance angiography (MRA) was normal. The patient was discharged home on day 13.

### Case 2

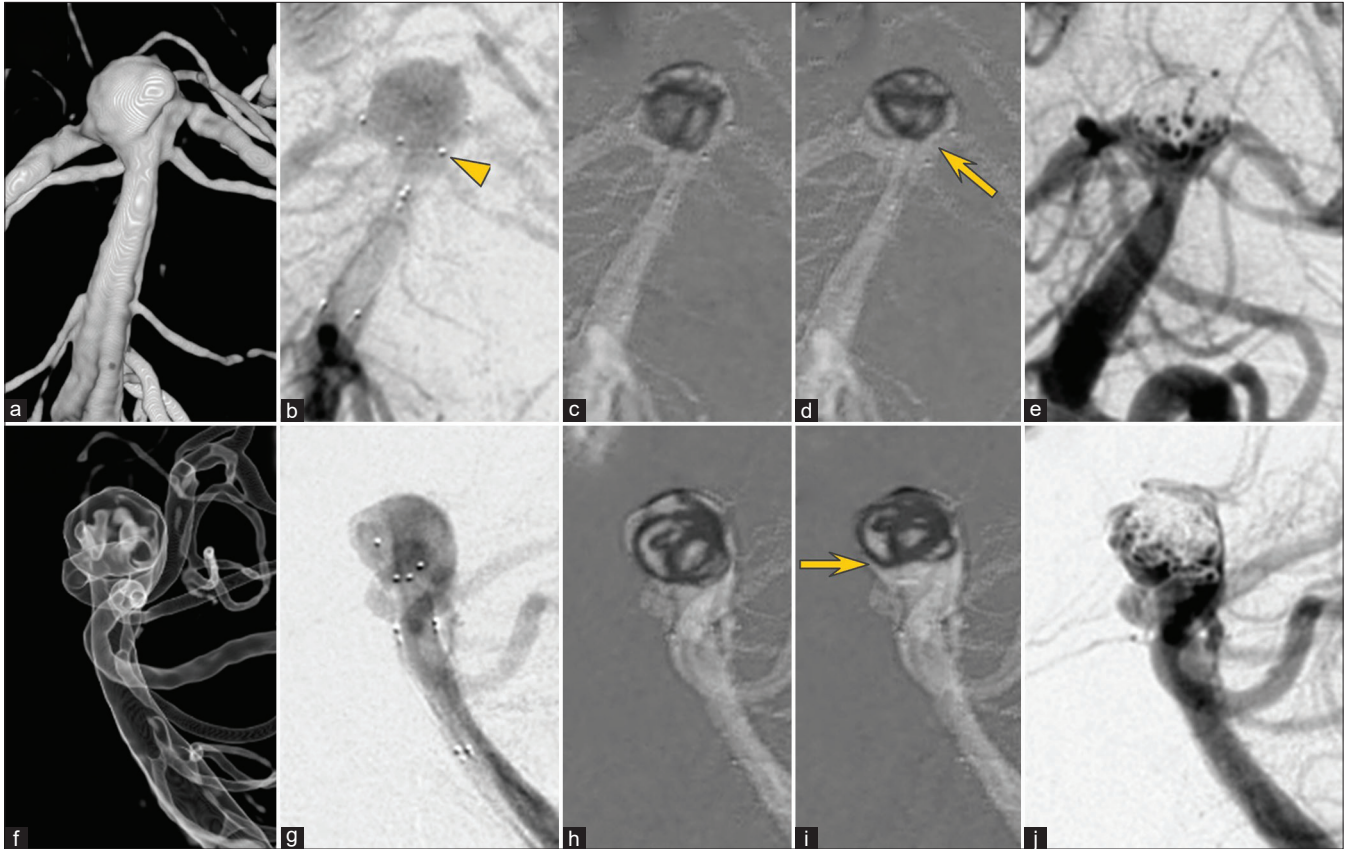
A 60-year-old woman presented with a ruptured left internal carotid artery aneurysm that was surgically clipped. Seventy-four days later, an unruptured basilar tip aneurysm was treated endovascularly. On angiography, both PCAs and SCAs branched off the wall in the middle of the dome [Figures 3a and f]. Aneurysm measurements were as follows: diameter, 7.6 mm; neck, 7.6 mm; and height, 3.9 mm. The aneurysm was extremely shallow with an aspect ratio of 0.5.

A PulseRider (10T/3.5–4.5) was deployed in the extra-aneurysmal position with the leaflets inside each PCA [Figures 3b and g]. An Axiom Prime Frame (5 mm × 15 cm) was inserted but easily deviated into the parent artery from the posterior space of the aneurysm. Therefore, the PulseRider was temporarily withdrawn proximally and a coil frame was created above it [Figures 3c and h]. The PulseRider was then advanced to elevate the deviated coil frame [Figures 3d and i]. The second half of the coil was reinserted and 10 coils were added to achieve successful embolization [Figures 3e and j].

### Case 3

A 74-year-old woman with a brainstem infarction showed an unruptured basilar tip aneurysm on MRA. Angiography showed incorporation of both PCAs and SCAs into the aneurysm wall; both PCAs branched laterally. Aneurysm measurements were as follows: diameter, 11 mm; neck, 11 mm; and height, 7 mm. Dome-to-neck and aspect ratios were 1.0 and 0.64, respectively. A PulseRider (10T/3.5–4.5) was deployed in the hybrid position, with the left leaflet in the left PCA and the right leaflet in the aneurysm. An Axiom Prime Frame (8 mm × 30 cm) was inserted but easily deviated. Therefore, the PulseRider was temporarily withdrawn proximally [Figures 4a and e] and a coil frame created above it [Figures 4b and f]. The PulseRider was then advanced to jack up the coil frame [Figures 4c and g]. In the lateral view, the underside of the coil frame was recessed upward [Figure 4g]. A total of 28 coils were added and successful embolization was achieved [Figures 4d and h].





**Figure 3:** (a-j) Angiography images of the basilar tip aneurysm in case 2. Panels are described in detail in the text. The yellow arrowhead indicates the PulseRider in the withdrawn position. The yellow arrows indicate the coil mass “jacked up” into the aneurysm.

## DISCUSSION

Wide-necked aneurysms are generally defined as those with a neck diameter of 4 mm or greater or a dome-to-neck ratio  $<2.0$ . These criteria are also considered indications for use of PulseRider in Japan. Brinjikji *et al.*<sup>[2]</sup> suggested that adjunctive techniques are mandatory for the treatment of aneurysms with a dome-to-neck ratio or aspect ratio  $<1.2$ , which they called “overwide and undertall” aneurysms. The three aneurysms presented here were very shallow and had an aspect ratio considerably below this threshold. Morphologically, both PCAs were incorporated into the aneurysm wall and bifurcated laterally. When the PulseRider was deployed in the standard position at the upper border of the bilateral PCAs, the coil easily deviated toward the parent artery. However, successful embolization was achieved using the PulseRider jack-up technique, in which the PulseRider was deployed more proximally than usual, the coil frame was constructed above it and then pushed up with the PulseRider.

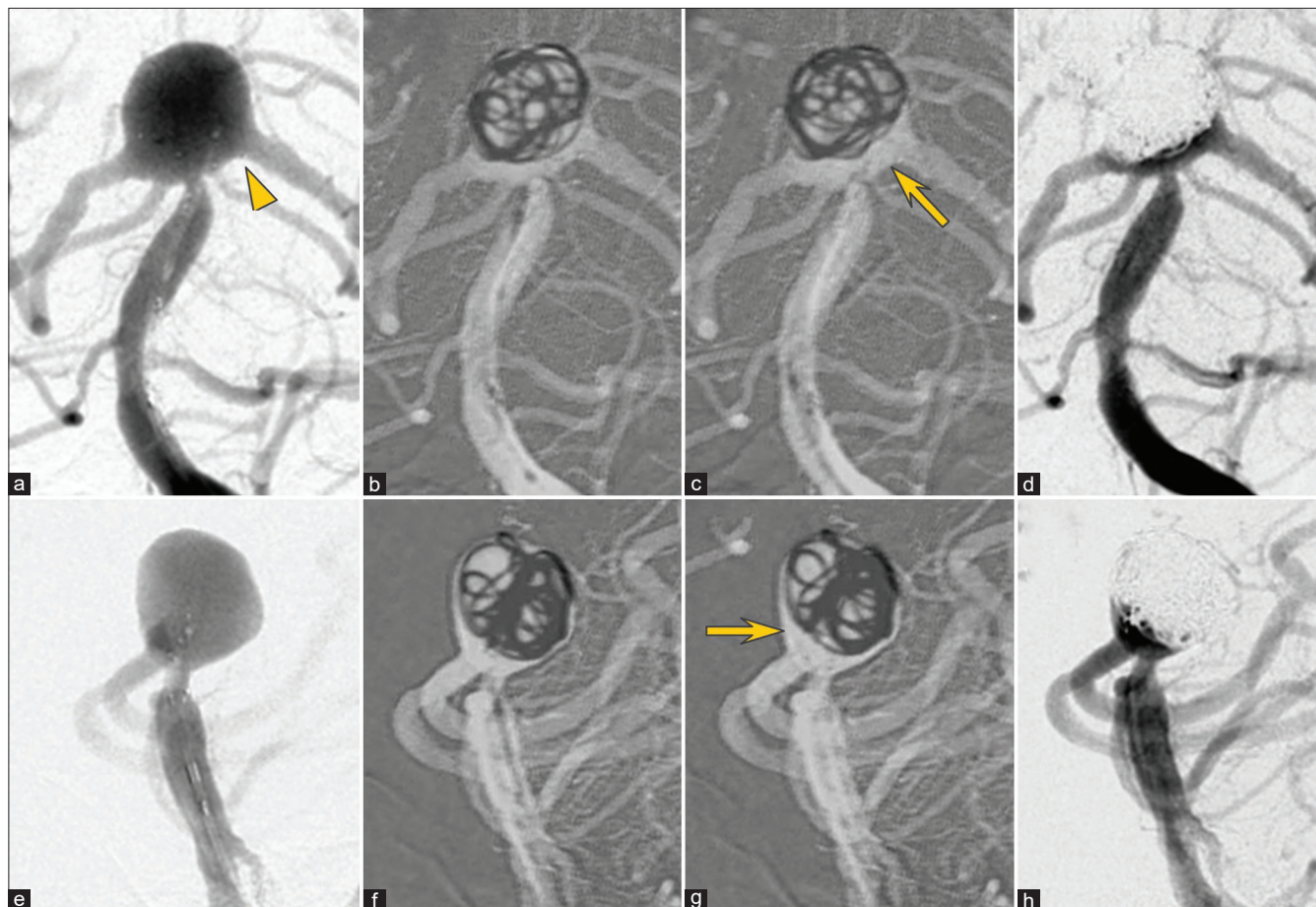
### Advantages of the PulseRider jack-up technique

The jack-up technique has several advantages. First, it is simpler and easier than balloon-assisted or stent-assisted techniques

since it does not require a wire or catheter to select branches. Second, before creating and jacking up the coil frame, the coil and PulseRider are not detached, allowing repeated and partial reinsertion of the coil, if necessary. Third, the coiling catheter is guided into the aneurysm with the PulseRider in a lower position than usual, which provides more distance between the catheter tip and the aneurysm and may reduce the risk of aneurysm rupture caused by jumping of the catheter. Fourth, if only a single coil is jacked up, the PulseRider’s handling is minimally compromised. Fifth, since the coiling catheter is not strongly fixed, it retains maneuverability. Sixth, the coils inside the aneurysm are minimally changed by the jack-up maneuver, whereas coils that deviate into the parent artery may be compressed and increase in density (especially in case 1). This may be advantageous for subsequent embolization. Finally, the low metal content makes PulseRider less thrombogenic, and therefore, although an off-label use, less antithrombotic medication may be required when used in ruptured aneurysms.<sup>[3]</sup>

### Challenges with the PulseRider jack-up technique

Potential complications of the jack-up technique include aneurysm perforation and parent artery dissection due to aneurysm or vessel injury caused by the PulseRider leaflets.



**Figure 4:** (a-h) Angiography images of the basilar tip aneurysm in case 3. Panels are described in detail in the text. The yellow arrowhead indicates the PulseRider in the withdrawn position. The yellow arrows indicate the coil mass “jacked up” into the aneurysm.

These can occur with standard PulseRider implantation as well as the jack-up technique. With the latter, leaflet visibility may be reduced because a coil is present. Therefore, we first place the PulseRider in its standard neck position to ensure good alignment with the neck and parent artery and then pull it back before advancing it again after the coil frame has been constructed. However, multiple device advancements may increase the potential for complications.

## CONCLUSION

The PulseRider jack-up technique is a simple and useful technique for coil embolization of wide-necked basilar tip aneurysms that incorporate the PCAs and SCAs. This method can serve as a rescue technique for cases in which standard PulseRider placement results in coil protrusion into the parent artery.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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**How to cite this article:** Inoue S, Fujita A, Kurihara E, Sasayama T. PulseRider “jack-up” technique for wide-necked basilar tip aneurysms that incorporate parent arteries: A technical note. *Surg Neurol Int* 2023;14:9.

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