

# Endovascular Parent Artery Occlusion of Ruptured Vertebral Artery Dissecting Aneurysms

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## ●Abstract●

**Objectives:** In recent years, endovascular treatment, especially parent artery occlusion, has become a first-line treatment for ruptured vertebral artery dissecting aneurysms (VADAs). This study reports the outcomes of endovascularly treated ruptured VADAs.

**Methods:** The subjects comprised 50 patients who underwent endovascular parent artery occlusion of ruptured VADAs between 2004 and 2011 (29 men, 21 women; mean age, 50.7 years [range, 28-74 years]). Hunt and Hess (H/H) grades just prior to endovascular treatment were grade 1 in 4 patients (8.0%), grade 2 in 8 (16.0%), grade 3 in 14 (28.0%), grade 4 in 9 (18.0%), and grade 5 in 15 (30.0%). Clinical outcomes were assessed using the Glasgow Outcome Scale. Locations of dissecting aneurysms relative to the ipsilateral posterior inferior cerebellar artery (PICA) were proximal type in 3 patients (6.0%), distal type in 25 (50.0%), PICA-involved type in 6 (12.0%), and non-PICA type in 16 (32.0%).

**Results:** Forty-two patients (84.0%) underwent internal trapping, and the remaining 8 patients (16.0%) underwent proximal occlusion. One patient rebled during the diagnostic angiography before the coil embolization procedure. There were no procedure-related complications. Clinical outcomes at discharge were good recovery in 26 patients (52.0%), moderate disability in 4 (8.0%), severe disability in 10 (20.0%), vegetative survival in 4 (8.0%), and death in 6 (12.0%). Notably, 41.5% of the patients with an H/H grade of 4 to 5 had a good clinical outcome.

**Conclusions:** This study shows that endovascular parent artery occlusion for ruptured VADAs is feasible and safe.

## ●Key Words●

clinical outcome, endovascular treatment, posterior inferior cerebellar artery, ruptured vertebral artery dissecting aneurysm

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## Introduction

Ruptured vertebral artery dissecting aneurysms (VADAs) comprise 3% to 7% of subarachnoid hemorrhages (SAHs) caused by cerebral aneurysms<sup>15)</sup>. Although ruptured VADAs have been treated with craniotomy with clipping or trapping<sup>16)</sup>, endovascular parent artery occlusion has become a first-line therapy. The purpose of this study was to report the results of endovascular treatment of ruptured VADAs.

## Materials and Methods

### 1. Patient population

We endovascularly treated 50 patients with ruptured VADAs between March 2004 and April 2011. All patients were treated at either Juntendo University Hospital or affiliated hospitals. There were 29 men (58.0%) and 21 women (42%) with a mean age of 50.7 years (range, 28-74 years). Hunt and Hess (H/H) grades just prior to endovascular treatment were grade 1 in 4 patients (8.0%), grade 2 in 8 (16.0%), grade 3 in 14 (28%), grade 4 in 9 (18.0%), and grade 5 in 15 (30.0%).

## 2. Locations of VADAs relative to the ipsilateral posterior-inferior cerebellar artery

The locations of VADAs relative to the ipsilateral posterior inferior cerebellar artery (PICA) were defined according to criteria previously described by Iihara et al.<sup>6)</sup> VADAs on the distal side of the PICA were defined as distal type, those on the proximal side as proximal type, and those in the PICA arising from a lesion as PICA-involved type. We originally defined non-PICA type as the absence of an angiographically recognized ipsilateral PICA.

## 3. Endovascular techniques

To control the intracranial pressure and washout of subarachnoid hematomas, the patients underwent lumbar or ventricular drainage before beginning endovascular treatment. Endovascular treatments were performed as soon as possible after admission. The timing of endovascular treatment after onset was within 24 hours in 17 (34.0%) patients, 24 to 48 hours in 12 (24.0%) patients, and more than 48 hours in the remaining 21 (42.0%) patients whose treatment was delayed because of their poor general conditions.

General anesthesia was administered to all patients to ensure stable vital signs and immobilization for clearer angiogram and road map imaging. After confirming hemostasis at the puncture site, systemic heparinization was started to maintain an activated clotting time at approximately twice the control value. Heparinization was stopped at the end of the procedure.

We considered that the primary endovascular strategy for ruptured VADAs was coil embolization of the dissecting aneurysm itself (i.e., internal trapping). If, however, this procedure was not appropriate for preservation of the ipsilateral PICA or could not be performed for technical reasons, coil embolization of the normal vertebral artery (VA) proximally close to the dissecting aneurysm (i.e., proximal occlusion) was indicated. Patients with hypoplastic VA contralateral to VADAs were not referred to us before a decision was reached by the previous physicians.

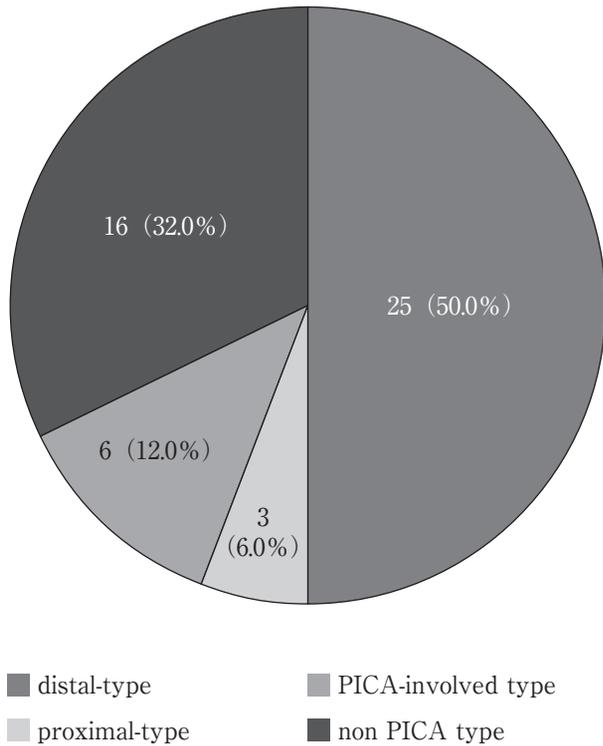
Our standard technique was as follows. A 6- or 7-Fr.

guiding catheter was placed in the treated VA via the femoral artery. A diagnostic 4-Fr. catheter was placed in the contralateral VA to evaluate the reversed blood flow to the dissecting aneurysm. The simple use of a single guiding catheter and single microcatheter was our primary technique. If, however, this simple technique could not be used, then a double-catheter technique using two microcatheters via a single guiding catheter could achieve satisfactory occlusion. If necessary, the microcatheter was advanced into the distal side of the dissecting aneurysm via the contralateral VA to achieve satisfactory occlusion. The main coils used were Guglielmi detachable coils (Stryker, Kalamazoo, MI, USA), Orbit Trufill and Mini Complex Fill coils and Micrus coils (Codman Neuroendovascular, Johnson & Johnson, Miami, FL, USA), and Electro Detach coils (Kaneka Medix Corporation, Osaka, Japan). After the procedure, medical management (hypertensive, hypervolemic, and hemodilution therapy) for vasospasm was performed. Aspirin (100 mg) was given on the day after treatment and continued for a few months.

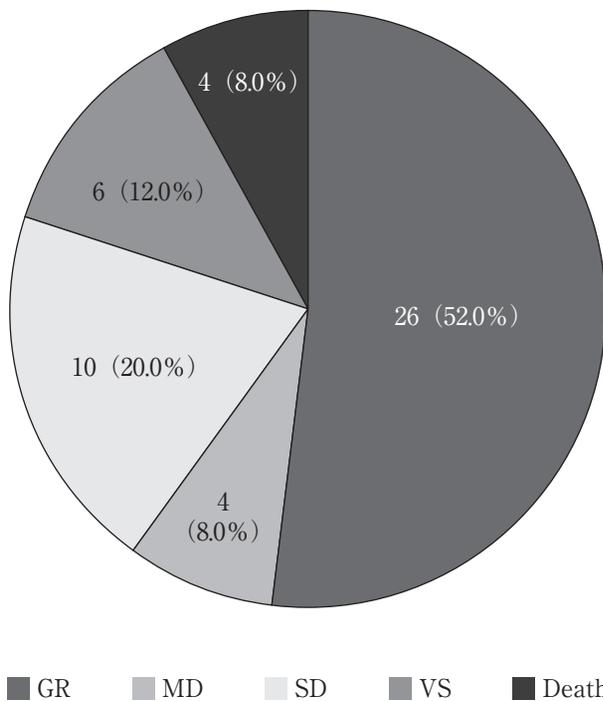
## Results

In our series, 42 patients (84.0%) underwent internal trapping, and the remaining 8 patients (16.0%) underwent proximal occlusion. Locations of VADAs relative to the ipsilateral PICA are shown in **Fig. 1**. All procedures were completed without any technical complications. One patient rebled during the diagnostic angiography. There were no clinical complications during the perioperative period.

Overall clinical outcomes at discharge are shown in **Fig. 2**. Clinical outcomes of H/H grades 1 to 3 and 4 to 5 are shown in **Table 1**. Patients with H/H grades of 1 to 3 had better outcomes than those with H/H grades of 4 to 5. **Fig. 3** shows the clinical outcomes at discharge in patients with an H/H grade of 4 to 5. Twenty-four patients underwent clinical follow-up over a mean period of  $22.2 \pm 41.0$  months (range; 2-60 months), including three patients with proximal occlusion of 2, 12, and 48 months duration, respectively. No re-bleeding was observed during the clinical follow-up period. The



**Fig. 1**  
Locations of vertebral artery dissecting aneurysms relative to the ipsilateral posterior inferior cerebellar artery.

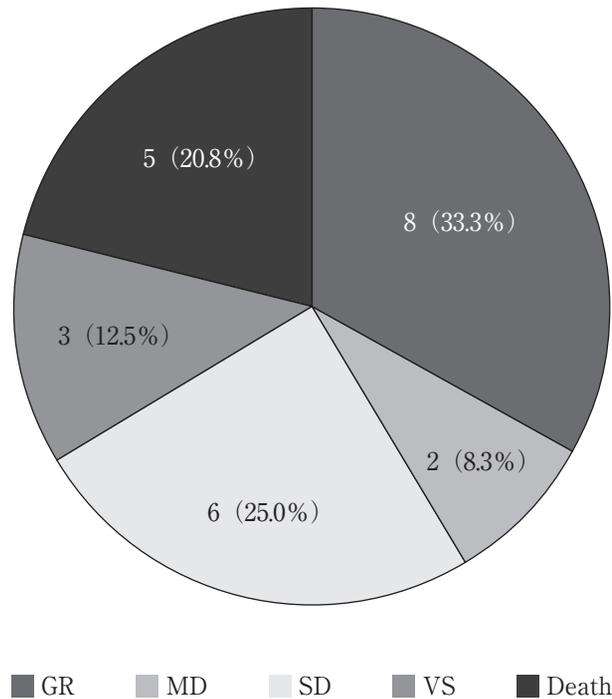


**Fig. 2**  
Clinical outcomes at discharge (Glasgow Outcome Scale).  
GR: good recovery, MD: moderate disability, SD: severe disability, VS: vegetative state

**Table 1** Clinical outcomes according to Hunt and Hess grade

	GR-MD	SD-Death
H/H grade 1-3	20 (76.9%)	6 (23.1%)
H/H grade 4-5	10 (41.7%)	14 (58.3%)

GR: good recovery, MD: moderate disability, SD: severe disability, H/H: Hunt and Hess.



**Fig. 3**  
Clinical outcomes of patients with Hunt and Hess grade 4 and 5 (Glasgow Outcome Scale) at discharge.  
GR: good recovery, MD: moderate disability, SD: severe disability, VS: vegetative state

remaining 26 patients were lost to follow-up because of death or other reasons.

None of the internally trapped VAs recanalized. Two patients with proximal occlusion underwent follow-up angiography more than 1 year after the treatment. Both of these patients had preservation of the PICA with no apparent change in the dissected VA. The remaining patient had asymptomatic occlusion of the PICA and dissected VA.

## Illustrative cases

### 1. Case 1 (PICA-involved type)

A 45-year-old woman presented with sudden onset of headache and impaired consciousness. The patient was diagnosed with SAH (H/H grade 2) based on the admission CT scans. Diagnostic angiography revealed a ruptured right PICA-involved type VADA (Fig. 4A). To preserve the PICA arising from the aneurysm, proximal occlusion was performed on day 0 (Fig. 4B, C). The patient's postoperative course was uneventful. She was discharged without any neurological deficits. Angiography 2 months later showed no apparent changes (Fig. 4D).

### 2. Case 2 (proximal type)

A 37-year-old woman presented with sudden onset of impaired consciousness and respiratory arrest. The patient recovered after resuscitation and was diagnosed with SAH (H/H grade 2). Diagnostic angiography revealed a ruptured right proximal type VADA (Fig. 5A). Re-bleeding occurred during the diagnostic angiography (Fig. 5B). Internal trapping was performed (Fig. 5C, D). The patient's postoperative course was uneventful. She was discharged without any neurological deficits. Angiography 1 year later showed no recurrence of the VADA and preservation of the ipsilateral PICA (Fig. 5E).

## Discussion

VADAs are generally categorized into bleeding and non-bleeding types. The rebleeding rate is very high (30–70%)<sup>1,10</sup> with a mortality rate of 46%<sup>2,4,7</sup> in patients with bleeding type VADAs. Therefore, patients with the bleeding type should be treated as soon as possible. Endovascular treatment is thought to be more advantageous than craniotomy with clipping or trapping because patients can undergo curative treatment following diagnostic angiography. The main treatment options for endovascular parent artery occlusion are internal trapping and proximal occlusion.

The strategy for endovascular treatment of ruptured VADAs depends on the location of the VADA relative to the ipsilateral PICA. Proximal occlusion is technically

simpler and easier than internal trapping. A couple of reports have indicated that proximal occlusion carries a risk of post-treatment rebleeding because of residual blood flow into the dissected VA<sup>11, 18</sup>. However, in the present study, no patients rebled after proximal occlusion. Internal trapping completely excludes the dissected VA from the circulation, while, in our series, two patients (one with proximal type and one with distal type VADA) underwent proximal occlusion because of difficult microcatheter insertion into the dissected VA. No patients had poor contralateral VA flow because of the triage by previous physicians. Stent-assisted coil embolization and bypass surgery have been reported in the literature<sup>3, 8, 14</sup>. The benefit of stent-assisted coil embolization is preservation of the dissected VA. However, it carries a risk of hemorrhagic complications because of the need for antiplatelet therapy.

The treatment strategy for the PICA-involved type remains controversial because rupture near the ipsilateral PICA is associated with the risk of an ischemic event. There are a few treatment options: proximal occlusion, internal trapping with or without occipital artery-PICA anastomosis, and stent-assisted coil embolization. Iihara et al. proposed a stage-dependent treatment strategy for PICA-involved type ruptured VADAs<sup>6</sup>. In the acute stage, endovascular proximal occlusion is performed to decrease the risk of rebleeding. In the chronic stage, balloon test occlusion is performed to evaluate tolerance for ipsilateral PICA occlusion. If the patient can tolerate ipsilateral PICA occlusion, internal trapping without bypass surgery is done. If the patient cannot, clip ligation of the origin of the ipsilateral PICA with occipital artery-PICA anastomosis is done. However, several authors have indicated that occlusion of the ipsilateral PICA is not clinically problematic because of sufficient collateral circulation<sup>5, 12</sup>.

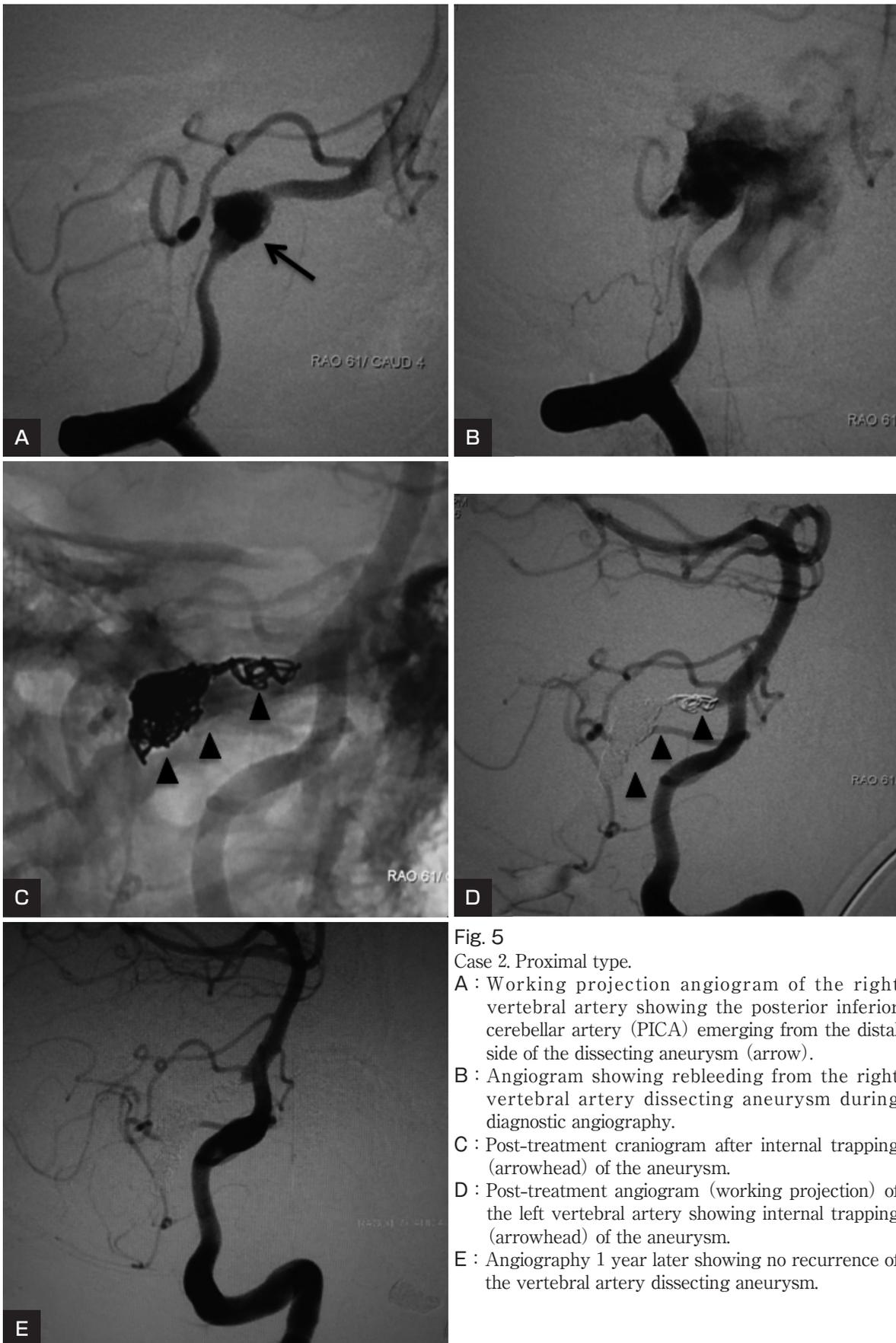
Clinical outcome of endovascularly treated ruptured VADAs has been reported as good recovery in 47% to 66.7% of patients, moderate disability in 11.1% to 29.4%, and death in 16.7% to 23.8%<sup>9, 13, 17</sup>. Our results are comparable with the findings in these reports. It is well known that patients with high-grade SAH have a poor



Fig. 4

Case 1. Posterior inferior cerebellar artery (PICA)-involved type.

- A : Working projection angiogram of the right vertebral artery showing the PICA arising from the dissecting aneurysm (arrow).
- B : Post-treatment craniogram after proximal occlusion (arrowhead) of the right vertebral artery.
- C : Post-treatment angiogram (working projection) of the left vertebral artery showing proximal occlusion (arrowhead) of the right vertebral artery.
- D : Angiography 2 months later showing no recurrence of the vertebral artery dissecting aneurysm. The angiogram shows remodeling of the aneurysm (arrowhead).



**Fig. 5**

Case 2. Proximal type.

**A :** Working projection angiogram of the right vertebral artery showing the posterior inferior cerebellar artery (PICA) emerging from the distal side of the dissecting aneurysm (arrow).

**B :** Angiogram showing rebleeding from the right vertebral artery dissecting aneurysm during diagnostic angiography.

**C :** Post-treatment craniogram after internal trapping (arrowhead) of the aneurysm.

**D :** Post-treatment angiogram (working projection) of the left vertebral artery showing internal trapping (arrowhead) of the aneurysm.

**E :** Angiography 1 year later showing no recurrence of the vertebral artery dissecting aneurysm.

prognosis. In our study, if patients with high-grade SAH were determined to have a poor chance of recovery, we monitored the patients condition. Therefore, some patients underwent treatment more than 48 hours after the onset of SAH. In our series, the outcome in 41.5% of the patients with an H/H grade of 4 to 5 was good recovery to moderate disability. Therefore, we recommend that aggressive treatment be considered for patients with VADA and high-grade SAH.

Taha et al. reported encountering complications of endovascular treatment of ruptured VADAs in 16.0% of patients (angiographic recanalization in 8.0% and ischemic event in 8.0%)<sup>17)</sup>. In our series, all procedures were completed without any technical complications. However, subtle clinical symptoms and equivocal radiological abnormalities might be missed because of initial brain damage and artifacts caused by endovascular procedures.

Because the present study involved retrospective data acquisition, a prospective study with a more rigorous technical and follow-up strategy is warranted. The patients in the present series are not representative of the whole population of patients with ruptured VADAs because surgically treated or untreated patients were not included in this study. Decisions regarding treatment indications may have resulted in an inclusion bias.

## Conclusions

Endovascular treatment for ruptured VADAs is feasible and safe. Protection from rebleeding is adequate if the appropriate technique is chosen based on the location of the VADA relative to the ipsilateral PICA.

The authors declare that they have no conflict of interest.

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