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Retrieval of Migrated Coils Using Stent Retrievers During Aneurysm Coiling: A Case Series and Literature Review

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Abstract

Background— Coil migration is a recognized complication during endovascular embolization of intracranial saccular aneurysms and can cause parent artery occlusion and ischemic stroke. There is no established technique or specifically designed rescue device to retrieve displaced or migrated coils.

Methods— Case series and literature review. We performed a literature review using keywords migrated coil, coil migration, coil retrieval, endovascular retrieval, displaced coil, and fractured coil on PubMed central (PMC).

Case Description— We report two cases describing off label use of a stent retriever (Trevo®; Stryker®, Fremont CA, USA) to retrieve migrated coils from the right internal carotid and right middle cerebral arteries after other retrieval devices had failed. The literature review identified 31 cases of coil migration.

Conclusions— We observed that stent retrievers can be used as a rescue device for migrated or fractured coils causing flow limiting occlusion.

Keywords— Coil migration, stent retrievers, saccular aneurysms, subarachnoid hemorrhage, stroke.

INTRODUCTION

Coil migration is a relatively infrequent complication during endovascular embolization of saccular aneurysms, coil malposition and migration that occurs in 2.5-6% of procedures [1-3]. Coil migration can be seen during coil embolization alone, stent assisted coiling and balloon remodeling technique. There are no guidelines for retrieving migrated coils, however previously described techniques usually include snare devices and retrieval devices. Migrated coil causing distal flow limitation may result in arterial thromboembolism and ischemic stroke [1,3,4]. On the contrary, migrated coils that are non-occlusive and do not have high potential to cause limitation of the blood flow distally can be managed conservatively.

We report successful retrieval of two migrated coils using off-label stent retriever (Trevo®; Stryker®, Fremont CA, USA). We also reviewed other case series and reports of this technique. [Table 1]

CASE DESCRIPTIONS

Case I

A 49-year-old woman, with history of hypertension, bronchial asthma, and prediabetes, presented with acute onset of "worst headache of life" and somnolence with no focal deficits on neurological examination. Her deficits were graded as Hunt Hess Grade III. Computed tomography (CT) of the head without contrast revealed pancisternal subarachnoid hemorrhage (SAH) which was mildly eccentric to the area of the right posterior communicating artery. Cerebral angiography [Image 1] demonstrated a right posterior communicating artery aneurysm posteriorly projecting and measuring 6.62 x 5.01 mm which was identified as the source of the SAH. Unruptured left posterior communicating artery and left anterior choroidal artery aneurysms were also identified. A decision to proceed with endovascular therapy was made. A 0.014-inch guidewire (Transend® platinum; Stryker®, Fremont CA, USA) and a microcatheter (Prowler 14; Codman) were introduced into the right posterior communicating artery aneurysm under roadmap fluoroscopic guidance. Then

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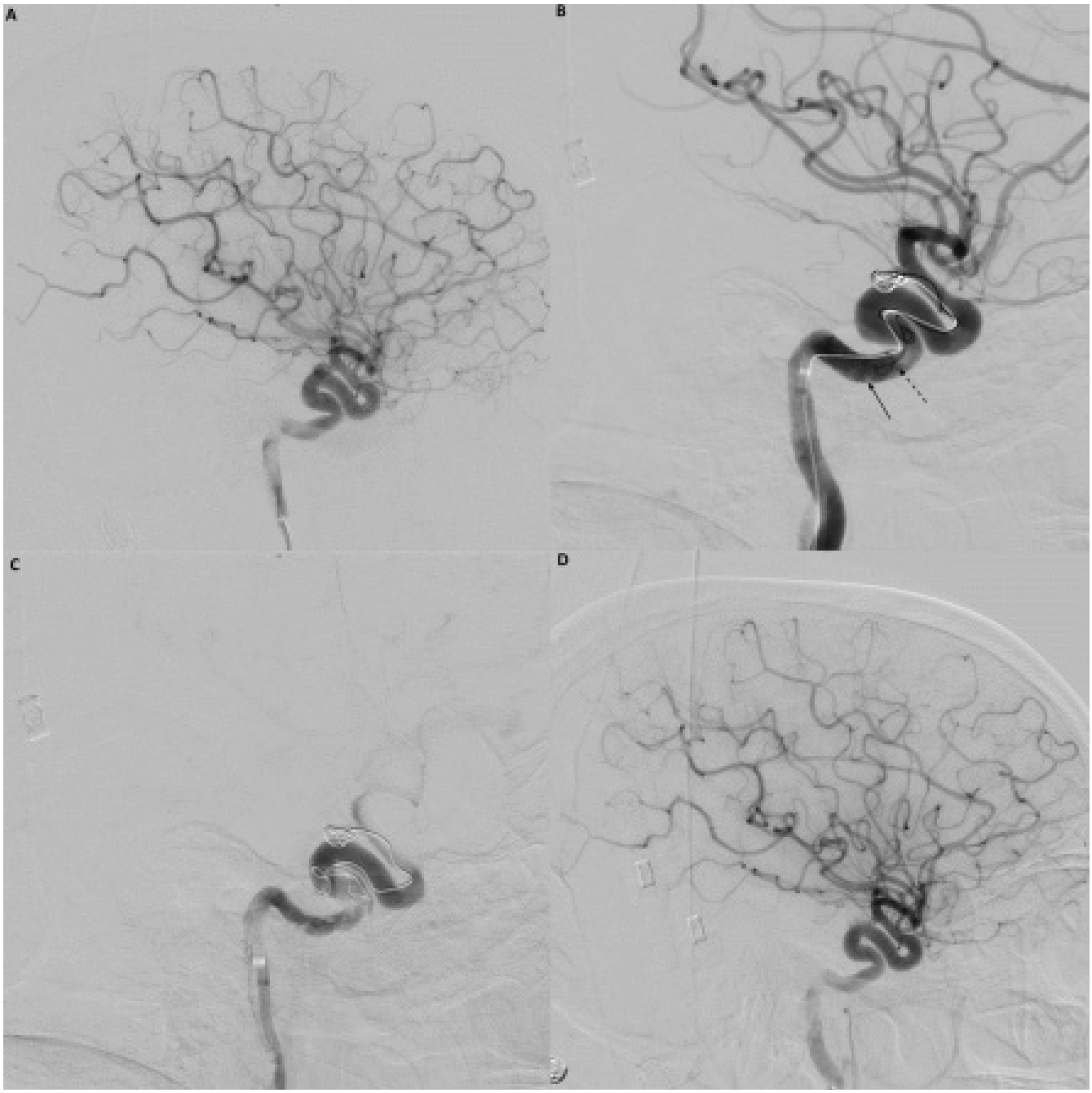

FIGURE 1: Case I. Cerebral angiography of the right internal carotid artery, lateral view: (A) posterior projecting right posterior communicating artery aneurysm. (B) Lateral working projection showing migrated (dashed arrow) and stretched (solid arrow) proximal coil segment within the right internal carotid artery. (C) Interval angiogram showing the migrated coil causing parent artery occlusion and flow limitation distal to the entangled coil. (D) Post coil retrieval and thrombectomy, single pass with Trevo, complete recanalization of internal carotid artery with Thrombolysis in Cerebral infarction (TICI) 3 distal flow and resolution of thrombus within the parent artery.

a 6-mm x 25 cm coil (Deltamaxx®; Codman Neuro) was introduced into the aneurysm but could not be retained within the aneurysm sac. During withdrawal, the coils stretched, fractured, separated from the delivery wire. The coil migrated proximally to the right internal carotid artery. A follow up angiogram revealed a free-floating stretched coil in the right internal carotid artery. IV bolus of heparin 5000 units was administered and followed by intermittent boluses to maintain activated clotting time (ACT) between 250-300 seconds. Multiple attempts to retrieve the coil using 2 mm and 4 mm retrieval device (Alligator™; Covidien) and a 10 mm snare device (Amplatz Goose Neck; Medtronic) were unsuccessful. Another follow up angiogram revealed that the stretched coil was still in the right internal carotid artery and portion of the coil was within the posterior communicating aneurysm. There was occlusion of the supraclinoid right internal carotid artery with patent carotid terminus confirmed on angiographic images acquired from contralateral internal carotid artery but with minimal distal blood flow. Collateral circulation was assessed with left internal carotid angiogram which showed patent left internal carotid, left middle cerebral, and left anterior cerebral arteries with good filling of the anterior communicating artery to the right anterior and middle cerebral arteries. However, there was a delay in the capillary phase with slowing of flow between the right middle cerebral artery and anterior cerebral artery border zone, which was an indication of inadequate collateral circulation. A 0.027-inch microcatheter (Marksman™; Covidien) over a guidewire (Fathom™;

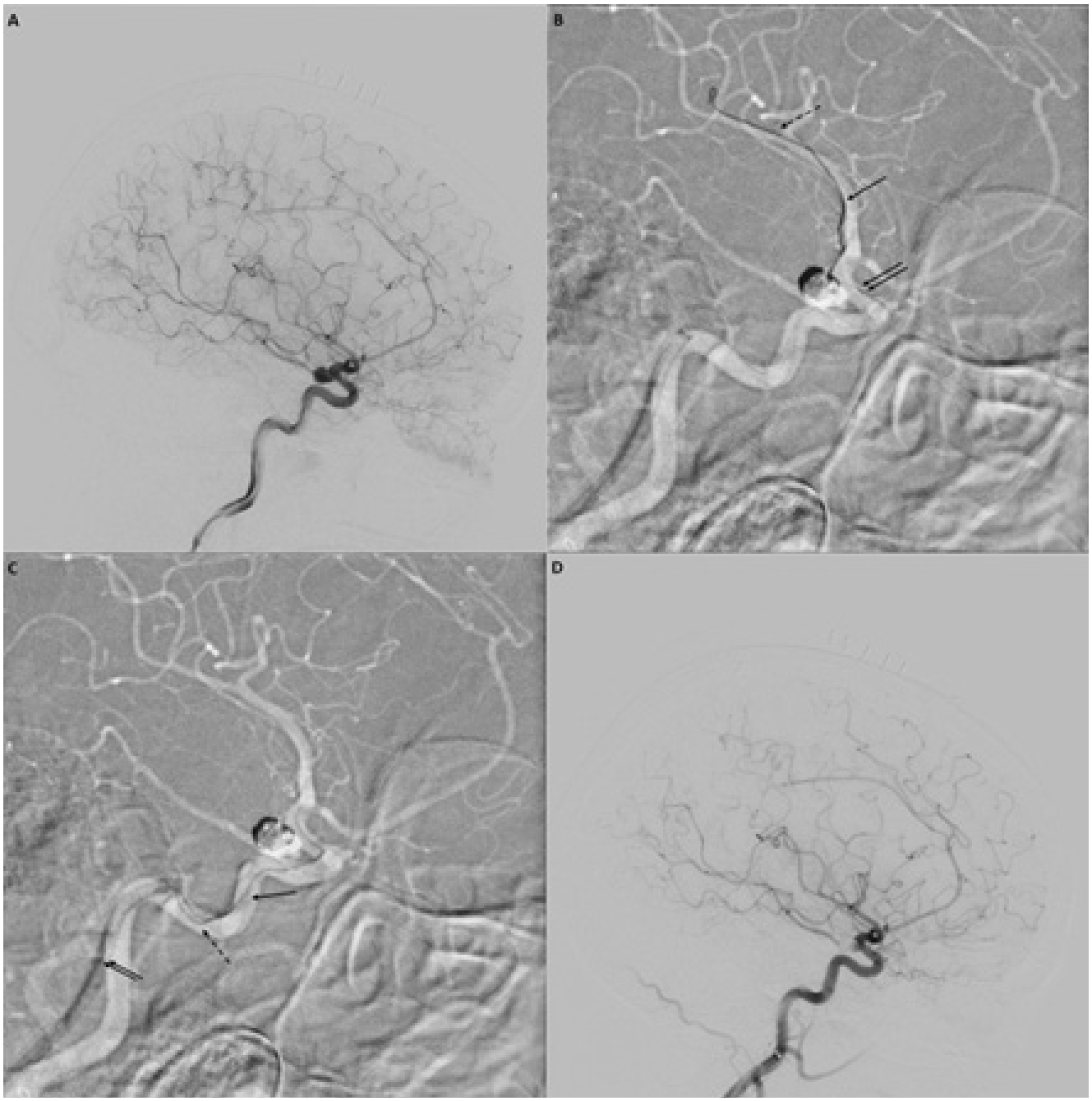

FIGURE 2: Case II. Cerebral angiography of the right internal carotid artery (A) Lateral view; showing a right PCOM aneurysm. (B) Oblique working projection; Trevo stent retriever (dashed arrow) deployed at the migrated coil (solid arrow) and stent retriever proximal marker (double arrow). (C) Oblique working projection; Trevo stent retriever (dashed arrow) being retrieved with the migrated coil (solid arrow) and stent retriever proximal marker (double arrow) in the guide catheter. (D) Lateral view; the migrated coil completely retrieved with normal blood flow with continued obliteration of right posterior communicating artery aneurysm.

Boston Scientific) introduced to the right internal carotid artery and positioned at the coil, then the wire was removed and a 6-mm stent retriever (Trevo®; Stryker®, Fremont CA, USA) used to engage the coil. The attempt was successful and the coil, stent retriever and microcatheter were removed as a single unit. A 6 mm stent retriever was selected to match the larger diameter of internal carotid artery. After retrieval of the coil with the stent retriever, there was no evidence of residual thrombus or presence or vasospasm at previously occluded internal carotid artery. Another follow-up angiogram demonstrated patent right internal cerebral, middle cerebral and anterior cerebral arteries with good flow in the capillary and venous phases and normal transit times. The posterior communicating artery aneurysm coil embolization was completed using two detachable coils; a 5 mm and 3 mm (Orbit Galaxy®; Codman Neuro, Raynham, MA USA). The final follow-up angiogram after embolization showed complete patency of parent artery with obliteration of aneurysm. Clinically and radiologically with MRI brain, there was no evidence of ischemia. Patient's hospital course was unremarkable with mild vasospasm identified by transcranial Doppler (TCD) without developing neurological deficits. At 3-month follow up the patient showed no neurological deficits with a modified Rankin Scale of 0.

Case II

A 63-year-old woman, with history of mild hypertension, presented with acute onset severe headache and rapidly progressed to unresponsiveness which required intubation for airway protection. CT head showed SAH with hydrocephalus that required external ventricular drain placement. CT angiography of the head showed a right posterior communicating artery aneurysm. Initial Hunt Hess grade was III and modified Fisher grade was III. A cerebral angiography [Image 2] showed a right posterior communicating artery aneurysm at the bifurcation of the fetal right posterior communicating measuring 8 x 6 mm with 4.34 mm neck. A 0.014-inch microwire (Synchro 2; Stryker®, Fremont CA, USA) inserted into a 0.025-inch microcatheter (PX SLIM™; Penumbra®, Almeda CA, USA) under roadmap fluoroscopic guidance into the right posterior communicating artery aneurysm. Anticoagulation was administered by IV heparin bolus of 6000 units followed by intermittent boluses to maintain ACT between 250-300 seconds starting during first coil deployment. The first coil PC 400 coil (Penumbra®; Almeda CA, USA) was deployed and detached successfully into the aneurysm. The second coil was a PC 400, 3 mm x 4 cm complex extra soft coil (Penumbra®; Almeda CA, USA). This coil was introduced into the aneurysm but was not suitable, so we proceeded with balloon remodeling technique using a scepter XC balloon catheter, 4 mm x 11 mm extra compliant (Microvention, Aliso Viejo, CA, USA). During manipulation of the coil within the aneurysm, the coil detached prematurely, and its proximal end migrated into the M2 branch of the middle cerebral artery. A snare multi-loop device (EN snare®; Merit Medical, South Jordan UT, USA) was prepared and introduced in proximity to the coil mass, however the attempt to engage it to the migrated coil was unsuccessful. We then used a 3 x 20 mm stent retriever (Trevo®; Stryker®, Fremont CA, USA) delivered through a 3MAX catheter (Penumbra®, Alameda, CA, USA) to engage the coil. During the first pass, the coil was engaged into the stent retriever and partially retracted to the proximal right internal carotid artery. However, the coil subsequently became loose from the stent retriever and migrated back to the M2 segment of the right middle cerebral artery. A second pass was attempted by reinserting the reperfusion catheter (3MAX™, Penumbra®, Almeda CA, USA) into the right middle cerebral artery and re-deploying the stent retriever. The coil mass engaged into the device and successful retrieval of the coil was obtained with assistance of aspiration using a 60-cc syringe through the Penumbra 088 MAX guide catheter without an intermediate catheter. The initial successfully placed coil remained in place without dislodging. The aneurysm was re-catheterized and successful coil embolization of the aneurysm was achieved using the following coils: PC 400, 2 mm x 2 cm curved extra soft coil and PC 400, 2 mm x 3 cm curved extra soft coil (Penumbra®, Alameda, CA, USA). The final follow-up angiogram showed demonstrated complete patency of parent artery with obliteration of aneurysm. The post-procedural CT scan and another CT head 4 days following the procedure showed interval improvement in the SAH with no evidence of ischemia. There was no clinical or radiographic vasospasm during hospital course. At 1-month follow up, there were no neurological deficits (modified Rankin Scale 0).

LITERATURE REVIEW

We performed a literature review for similar published cases between 2005-2019. We used PubMed central (PMC) to search for journal articles published in English. The main keywords used were migrated coil, coil migration, coil retrieval, endovascular retrieval, displaced coil, and fractured coil. Several isolated case reports and three case series demonstrated the successful use of stent retrievers (see Table 1). Two case reports discussed the use of (Trevo®; Stryker®, Fremont CA, USA) without concurrent aspiration; in one of the two cases coil retrieval was attempted but not successful with Alligator device. [5,6]. Another four case reports [7-10], and a case series of 2 cases [11] demonstrated the successful use of stent retriever Solitaire™(Medtronic). Two case series; one of 14 cases and one of 5 cases used either Solitaire stent retriever or catch plus thrombectomy device (Balt, Montmorency, France) [12,13] (see Table 1).

DISCUSSION

In our case series, attempts using (Trevo®; Stryker®, Fremont CA, USA) stent retriever were successful without complications, when attempts using snare retrieval devices were unsuccessful. In our two cases, it was necessary to retrieve the coils due to angiographic images demonstrating occlusion or distal embolization. Most of the previously published case reports and technical notes which used stent retrievers [5-16], primarily used the Solitaire stent retriever (Medtronic, Minneapolis, MN, USA) which does not have a closed cell design. The Trevo stent retriever was chosen because it has a closed-cell design, which we assumed may confer better apposition to the coil and vessel wall. Additionally, the high radio-opacity of the Trevo allowed for good visualization of its deployment to the migrated coil. We deployed the Trevo by the push-and-fluff technique that has been described for mechanical thrombectomy [17]. Subsequent re-sheathing the stent retriever proximal to the coil which allows better entrapment of the coil inside the device [5,12].

HELPS, a prospective randomized trial compared periprocedural safety during coil embolization in patients with intracranial aneurysm reported that coil migration occurred among 6% of cases using hydrogel coils and 4% with bare platinum coils [2]. In 2004, a retrospective study of 1811 patients who underwent endovascular treatment of intracranial aneurysm reported a rate of 2.5% for coil malposition [3]. Wide aneurysm neck is the most common cause for migrated and displaced coils [15], other causes like tortuous vessels, unstable position of the microcatheter, undersized coils, early coil detachment, and high flow conditions have been associated with coil migration [18].Common techniques used to retrieve coils are wire techniques, snare devices, aspiration, and stent retrievers; other less frequently used methods like intravascular coil retrieval using a microhook and fixing coil fragments into vessel walls using stents [1]. Wires were used to retrieve coils by dual guidewire technique [19] or manually shaping the microwire tip like a pigtail to be used similar to a snare device [20]. Several reports described the use of snare

TABLE 1: Reported cases for successful retrieval of migrated coils.

Reference	Retrieval Device	Aneurysm	Migration/ Displacement artery	Coil type
Henkes et al (2006) [18]	Alligator	Tip of Basilar artery	Basilar artery bifurcation	Sapphire
Vora et al (2008) [16]	L5 MERCI	Left Vertebral artery	Intradural vertebral artery	NXT platinum (7mm)
O'Hare et al (2009) [15]	X6 MERCI	Right PCOM	Right MCA	Microplex 10 (3x7 mm)
O'Hare et al (2010) [7]	Solitaire	Right PCOM	Right ICA	Microplex platinum
Hopf-Jensen et al (2013) [8]	Solitaire	Ophthalmic segment of right ICA	Right ICA	Target 360°
Leslie-Mazwi et al (2013) [12]	Solitaire stent/Catch plus device	Multiple (14 cases)	Multiple (14 cases)	-
Liu et al (2014) [5]	Trevo	Left PCOM	Left MCA	2 Hydroframe coils
Kabbani et al (2014) [6]	Trevo	Left ICA	Left ACA/Left pericallosal artery	Penumbra (10 mm x 40 cm)
Nas et al (2016) [9]	Solitaire	Right ICA/Right PCOM junction	Right ICA	Guglielmi (18 mm x 30 cm)
Singh et al (2016) [11]	Solitaire	Case 1: ACOM	Right callosomarginal artery	Microplex (1.5 x 1mm)
	Solitaire	Case 2: Right PCOM	Right MCA	Codman (1.5 x 2 mm)
Afzal et al (2017) [14]	Trevo	PCOM	MCA	-
Amuluru et al (2018) [10]	Solitaire	Right ICA	Right MCA	Orbit Galaxy complex xtrasoft
Zhou et al (2019) [13]	Catch plus mini stent retriever	ACOM	ACA (A2)	-
	Catch plus mini stent retriever	MCA	MCA (M2)	GDC 360 soft coil
	Solitaire	ACA	MCA (M2)	GDC 360 soft coil
	Catch plus mini stent retriever	ACOM	ACA (A2)	GDC 360 soft coil
	Solitaire	ICA	Right MCA	-

Abbreviations used:

PCA	Posterior cerebral artery	ICA	Internal carotid artery
PCOM	Posterior communicating artery	ACA	Anterior cerebral artery
MCA	Middle cerebral artery	ACOM	Anterior communicating artery

devices using twist technique [21] or monorail technique [22]. A recent report described the use of direct aspiration to retrieve migrated coil from the middle cerebral artery similar to aspiration thrombectomy of an acute thrombus [23].

It should be noted that stent retrievers are more expensive than other retrieval devices; with a typical purchasing costs in the USA of $5500-$7000 for stent retrievers and $1000-$3400 for other retrieval devices. It remains unclear whether using stent retrievers as a first-line rescue device is more cost-effective or not. While the present case series and previous studies demonstrate the feasibility and effectiveness of this approach, future studies are warranted to provide systematic ascertainment of outcomes.

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