Occlusion of Small Arteries in the Neuroendovascular and Head and Neck Territory—Initial Experiences with a Microvascular Plug

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ABSTRACT

The microvascular plug (MVP, UNO; Reverse Medical Corp, Irvine, California) is designed for occlusion of small vessels that are accessible only by microcatheters. This report describes eight neuroendovascular cases, including aneurysms and acute or imminent hemorrhage, treated with 10 microvascular plug devices. Instantaneous flow arrest was observed in all but two cases, in which the device was undersized, requiring supplementary coiling or microvascular plug replacement, respectively. Persistent occlusion was confirmed on follow-up examinations. There was one adverse event, which involved inadvertent device detachment after repeated resheathing. The microvascular plug appears to be suitable for the designated purpose. Further studies need to evaluate safety and confirm long-term durability of the results.

ABBREVIATIONS

ICA = internal carotid artery, PTFE = polytetrafluoroethylene

Diverse pathologic conditions may necessitate endovascular occlusion of an extracranial or intracranial blood vessel. The microvascular plug described in this report (MVP, in its dedicated neuroendovascular version marketed as UNO; Reverse Medical Corp, Irvine, California) is an endovascular tool designed for instantaneous, complete occlusion of relatively small target vessels with one device. Published data on this relatively new device are few and preliminary. There are only two small retrospective studies: one on microvascular plug embolization of gastrointestinal arteries (1) and a recent case series of eight patients, which represents the only published material on neuroendovascular use of the microvascular plug (2). The present report extends these data and describes preliminary experiences with this device in a series of patients with diverse pathologies of the intracranial and extracranial vasculature.

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MATERIALS AND METHODS

This retrospective single-center case series was approved by the institutional review board and is in accordance with the 1964 Declaration of Helsinki and its later amendments. It includes all eight patients with head and neck or neuroendovascular pathologies treated with the microvascular plug between September 2013 and July 2014 at our institution. In all, 10 devices were deployed. All procedures were carried out on a biplane angiography system (Allura XPer FD10/20; Philips, Eindhoven, The Netherlands). Vessel diameters were reassessed using computed tomography (CT) angiography or contrast-enhanced magnetic resonance (MR) imaging performed before treatment, which was available for all patients.

The microvascular plug consists of a wide-meshed nitinol structure, partially lined, in its proximal part with a polytetrafluoroethylene (PTFE) membrane (**Fig 1**). Both the proximal and distal tips of the nitinol exoskeleton carry one radiopaque marker. The device is deployed by withdrawal of the delivery microcatheter and then detached from the carrier wire electrolytically. This design allows complete resheathing for repositioning or removal. The microvascular plug is available in two sizes, with nominal diameters of 3 mm and 5 mm for vessels 1.5–3 mm and 3–5 mm, respectively. The overall length is 12 mm for both sizes, with the PTFE-lined part extending approximately over the

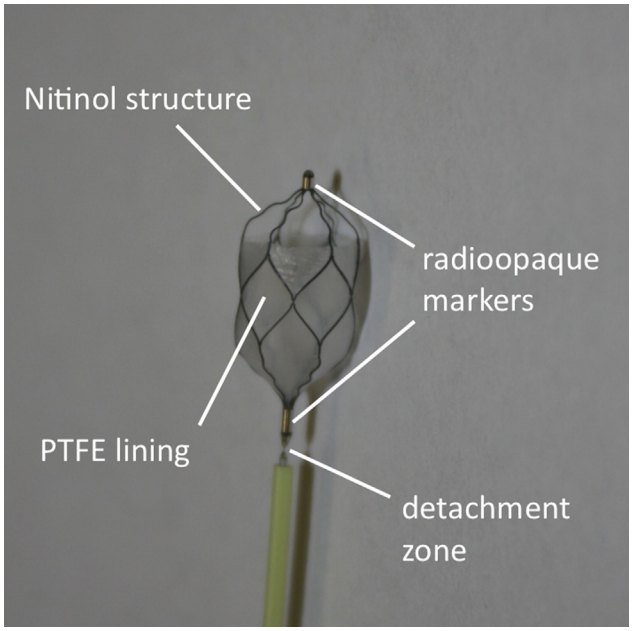

Figure 1. Microvascular plug device. (Available in color online at *www.jvir.org*.)

proximal three quarters (ie, 9 mm). The 3-mm and 5-mm devices are compatible with standard 0.021-inch and 0.027-inch microcatheters, respectively.

RESULTS

Data on clinical background, vessel diameters, endovascular treatment, and follow-up examinations are summarized in the **Table**. Two illustrative patients are described in detail in **Figures 2a–c** and **3a–c**. In all cases (10 of 10 devices deployed), the target vessel could be reached and the device could be deployed at the intended site. In 9 of 10 cases, the device was also detached precisely at the intended site. In one case (device 7 in the **Table**), the microvascular plug was inadvertently detached during redeployment after two preceding resheathing maneuvers. In this case, the therapeutic goal was preventive occlusion of the common carotid artery and proximal internal carotid artery (ICA) because of malignancy-induced erosion of the vessel wall. The MVP-5 (Reverse Medical Corp), initially selected for distal occlusion of the ICA and as an anchor for subsequent coiling of the proximal vessel segment, turned out to be too small and was replaced by a 7-mm AMPLATZER Vascular Plug (St Jude Medical, St Paul, Minnesota). Thereafter, the microvascular plug was reinserted and used as additional embolic material in conjunction with several standard coils to occlude the common carotid artery and ICA proximal to the AMPLATZER Vascular Plug. The inadvertent detachment, which occurred during this "off-label" maneuver, had no clinical consequences but was viewed as a potentially hazardous adverse event.

In one additional case (device 1 in the **Table**), there was minor residual flow between the device and vessel wall, requiring supplementary coiling. In both cases with residual flow, the assessment of CT angiography performed before treatment indicated that the devices chosen had been undersized for the target vessel segment, by $\sim$ 0.3 mm and $\sim$ 0.2 mm (**Table**). In all other cases (8 of 10), with appropriate sizing, instantaneous complete flow arrest was observed after device deployment. Follow-up examinations by CT angiography, MR imaging, or digital subtraction angiography at intervals from 2–180 days showed persistent occlusion of the target vessel in all cases, including cases in which the microvascular plug had been used as the sole device (devices 2, 4–6, 8, 9 in the **Table**).

DISCUSSION

The present case series indicates that the microvascular plug is a suitable instrument for occluding relatively small and tortuous arteries in the head and neck and intracranial territories. This finding is in accord with the one published small neuroendovascular case series on the microvascular plug (2). The study by Gandhi et al (2) comprised eight patients and cases of traumatic hemorrhage, occlusion of parent arteries of arteriovenous fistulas, and fusiform vertebral artery aneurysms (pseudoaneurysms) and reported immediate occlusion in all cases. The present series confirms and extends these previous experiences but also draws attention to a potential safety issue.

One main advantage of the microvascular plug is its microcatheter compatibility. In the present case series, all target sites could be reached. The potential performance of the device is well illustrated by sample case 1, in which the microvascular plug could be navigated through the left vertebral artery and vertebral artery junction and in a retrograde manner down the right vertebral artery to its origin from the pseudoaneurysm remnant and deployed precisely at the intended site without impediments or complications.

In 9 of 10 cases, the device could be deployed at the intended location. However, in one case, the device was inadvertently detached after repeated resheathing. This detachment occurred during a maneuver that was out of the designated application range of the device and, owing to the special circumstances, had no clinical consequences. However, premature release of a vessel-occluding device can have disastrous consequences, in particular, in cerebral arteries, and represents a serious issue. Before the device can be considered safe, further studies are required to show that such an event is absolutely exceptional. Repeated resheathing of the microvascular plug should be strictly avoided in situations in which inadvertent detachment would pose a potential hazard to the patient.

The two instances with residual flow that required additional coiling or device removal (devices 1 and 6 in the **Table**) were due to undersizing, as shown by assess-

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