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C A Jungreis, A Berenstein and I S Choi

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Use of an Open-Ended Guidewire: Steerable Microguidewire Assembly System in Surgical Neuroangiographic Procedures

Charles A. Jungreis,[1,2] Alex Berenstein, and In Sup Choi

Therapeutic embolizations (surgical neuroangiographic procedures) in the head, neck, meninges, spine, and spinal cord are now accepted modes of treating vascular tumors and vascular malformations [1–4]. We report our experience over the past 18 months with an open-ended guidewire through which we injected embolic agents. The purpose of the open-ended guidewire is to reach a more selective position in an attempt to save normal-functioning territories. In addition, a steerable microguidewire is used for further advancement of the open-ended guidewire. At present, these delivery systems are a routine and indispensable tool in our patient management routine.

Materials and Methods

Over the last 18 months, 85 procedures were performed on 58 patients for a variety of pathologic conditions (Table 1). Ages ranged from 8 months to 74 years old. In each procedure an average of three to four different pedicles were embolized using either liquids (isobutyl-2-cyanoacrylate or 95% ethanol) or particulate agents (Gelfoam powder or polyvinyl alcohol particles 40–140 μm) or a combination thereof. More than 200 pedicles were embolized.

Embolization was performed either for palliation of pain, as a preoperative hemostatic procedure, or as the primary mode of treatment.

The open-ended guidewire is used in a manner similar to that of conventional guidewires. In appearance it is similar to the common "movable core" type of wire; however, the inner core is completely removable thereby permitting injections through the outer sleeve. A Teflon jacket coats the outer sleeve and prevents leakage. The Teflon also creates a tip that is atraumatic. Open-ended guidewires are manufactured by several companies; the ones used in this report are from USCI (Billerica, MA). They are available in two sizes, 0.038 in. and 0.035 in. (Fig. 1).

The wire position can be even further advanced with the assistance of the new steerable microwires that were introduced for cardiac angioplasties [5]. These steerable wires also are manufactured by several companies. Those used in this report are from ACS (Mountain View, CA) and are available in two sizes, 0.018 in. and 0.014 in. They consist of a long, stiff, proximal shaft; however, the last 3 cm are made of a very soft radiopaque platinum microwire that provides good visibility despite its small size. A variable curve is made in the platinum tip before use (Fig. 2). The one-to-one torque response of this microwire is remarkable, allowing very precise manipulations.

TABLE 1: Summary of Cases

Diagnosis	No. of Cases	Embolic Agents
Head and Neck		
Facial AVMs	29	IBCA/PVA
Hemangiomas	3	IBCA/PVA
Dural AVM[a]	19	IBCA/PVA
Paraganglioma	6	IBCA/PVA
Epistaxis	3	PVA
Astrocytoma[b]	1	95% EtOH
Spine		
Metastases (Renal cell carcinoma)	12	95% EtOH/PVA
Dural AVMs	5	IBCA/PVA
Medullary AVMs	1	IBCA
Hemangioblastomas	1	IBCA
Miscellaneous		
Pelvic AVMs	3	IBCA/PVA
Osteoblastoma in C1 vertebra	1	IBCA
Paraspinal angiosarcoma	1	IBCA/PVA
Total	85	

Note.—IBCA = isobutyl-2-cyanoacrylate; EtOH = ethanol; PVA = polyvinyl alcohol.

[a] One case was the dural component of a mixed dural-pial arteriovenous malformation (AVM).

[b] Parasitic dural supply to the tumor was embolized preoperatively with 95% ethanol.

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[1] All authors: Section of Surgical Neuroangiography, New York University Medical Center and Bellevue Hospital Medical Center, 560 First Avenue, New York, NY 10016.

[2] Present address: Department of Radiology, Section of Neuroradiology, University of Pittsburgh, Presbyterian University Hospital, DeSoto at O'Hara Streets, Pittsburgh, PA 15213. Address reprint requests to C.A. Jungreis.

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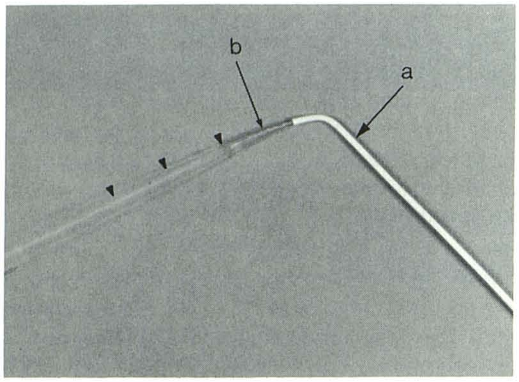

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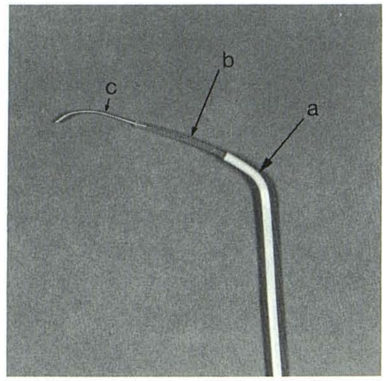

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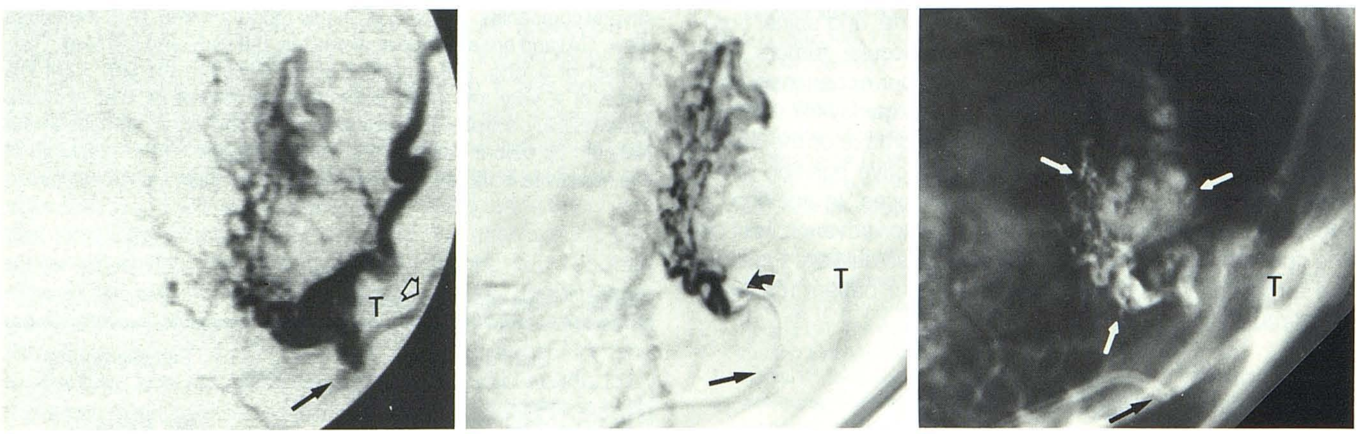
Fig. 1.—Coaxial assembly system using a superselective catheter (a) and an open-ended guidewire (b) through which injections of contrast material, liquid embolic agents, cytotoxic infusions, or microparticles can be injected. (*Arrowheads* point to injected fluid.)

Fig. 2.—Coaxial system using superselective catheter (a), open-ended guidewire (b), and steerable platinum-tip microguidewire in which a small curve has been made (c).



A B C

Fig. 3.—*A*, Lateral DSA. Coned-down view of injection into distal occipital artery supplying a dural arteriovenous malformation. Superselective catheter (*closed arrow*) could be placed beyond occipital-vertebral anastomosis; however, cutaneous branches (*open arrow*) of occipital artery would not have been spared in this position. (T = torcula.)

B, Lateral subtracted angiogram of superselective catheterization of transtorcular feeder with open-ended guidewire (*curved arrow*). Berenstein superselective catheter (*straight arrow*). (T = torcula.)

C, 100 mm spot radiograph shows radiopaque cast obtained (*white arrows*). Note that conventional superselective catheter (*black arrow*) remains in a position that would permit control angiography or additional coaxial embolization if necessary.

The open-ended guidewire is introduced coaxially through an angiographic catheter. We used the Berenstein superselective catheter (USCI, Billerica, MA). Road-mapping digital subtraction angiography is an invaluable aid in the precise placement of the open-ended guidewire.

The main use for the open-ended guidewire is to inject liquid embolic agents, such as isobutyl-2-cyanoacrylate (IBCA) (Ethicon, Inc., Somerville, NJ) or ethanol. Injecting IBCA through the open-ended guidewire has not proven any more difficult than injecting it through calibrated-leak balloon catheters. In fact, control of the injection may be easier with the open-ended guidewire. It is also easy to inject small particles of Gelfoam powder or polyvinyl alcohol foam in relatively low concentrations through the open-ended guidewire.

Results

The open-ended guidewire has regularly allowed catheterization of the intracranial middle meningeal artery, the transcranial branches of the occipital artery, and the distal branches of the internal maxillary and lingual-facial trunks. These vessels are not usually able to be catheterized. In addition, our impression is that the open-ended guidewire often can be better seated in the musculospinal artery, the ascending cervical artery, and the intercostal arteries than can conventional catheters.

Our results were a marked decrease and/or elimination of the blood supply to the lesions in almost every case. The single "unsuccessful" case was that of a patient with a meningioma who was sent to us for preoperative embolization. However, the presence of extremely tortuous vasculature prevented a satisfactory catheterization, and therefore no embolization was performed.

In another case, the superficial temporal artery was dissected during manipulation of the open-ended guidewire, but the area was easily traversed in a second procedure 3 days later. In a third case, cutaneous erythema of the patient's cheek occurred in a 1 × 2-cm area after embolization of a facial arteriovenous malformation, but it resolved spontaneously within a week.

It is noteworthy that we have not accidentally glued the open-ended guidewire in place, which is probably because of the accurate control of the injection it affords, in contrast to that of calibrated-leak balloons.

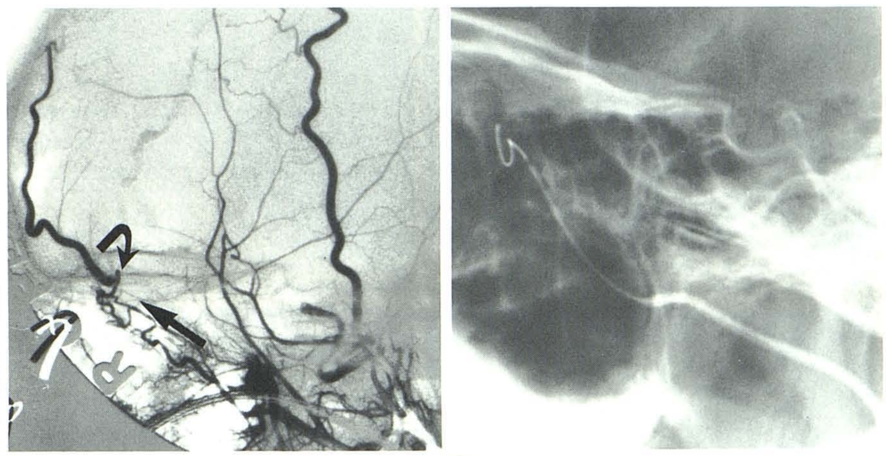
Discussion

Therapeutic embolizations in the craniofacial area, meninges, spine, and spinal cord for the treatment of vascular tumors and vascular malformations can be hazardous because of the many anastomoses with the vessels supplying the CNS and the cranial nerves. This is of particular concern when using liquid agents such as IBCA, ethanol, or microparticles, which, although more dangerous, have proven in our experience to be the most effective agents for endovascular treatments. We have been greatly aided by the use of an open-ended guidewire in conjunction with a steerable microguidewire in a coaxial assembly. This system has permitted better penetration into the angioarchitecture of the abnormality while sparing the normal territories. While use of the open-ended guidewire in the abdomen has been reported [5, 6], we have combined it with a steerable microwire in a coaxial fashion and believe that such use in surgical neuroangiographic procedures has significantly improved our ability to perform these procedures thoroughly and safely.

The following examples demonstrate the effectiveness of this delivery system in various territories.

Figure 3 shows a dural arteriovenous malformation fed by a branch of the occipital artery at the level of the torcula. While our conventional superselective catheter could be po-

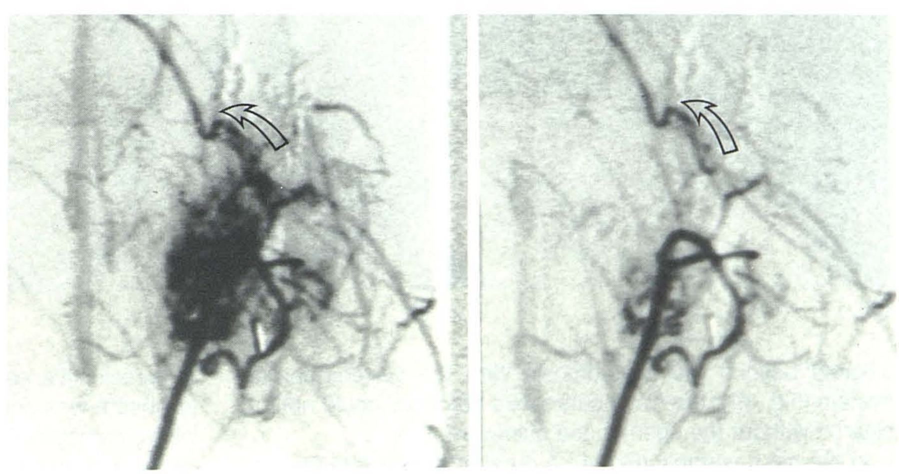
Fig. 4.—Dural arteriovenous malformation. Lateral spot radiograph shows ability of open-ended guidewire (*arrow*) to extend beyond origin of inferolateral trunk. In addition, petrosal branch of middle meningeal artery, which normally originates 11–15 mm distal to foramen spinosum (*asterisk*) and supplies 7th cranial nerve, is also spared.



A B

Fig. 5.—*A*, Lateral subtraction angiogram of external carotid artery shows anterior deep temporal artery (*straight arrow*) reconstituting anterior branch of superficial temporal artery (*curved arrow*).

B, Lateral radiograph shows coaxial assembly system with open-ended guidewire positioned in distal position to avoid ophthalmic complications.



A B

Fig. 6.—*A*, Frontal DSA examination with conventional catheter (no open-ended guidewire) of ascending cervical artery supplying the most inferior portion of a vagal paraganglioma. There is an important anastomosis between ascending cervical and vertebral arteries (*arrow*).

B, Postembolization study shows almost complete obliteration of tumor angioarchitecture but preservation of ascending cervical-vertebral anastomosis (*arrow*) (compare with *A*). Open-ended guidewire (not shown) had been advanced beyond vertebral anastomosis for injection of isobutyl-2-cyanoacrylate.

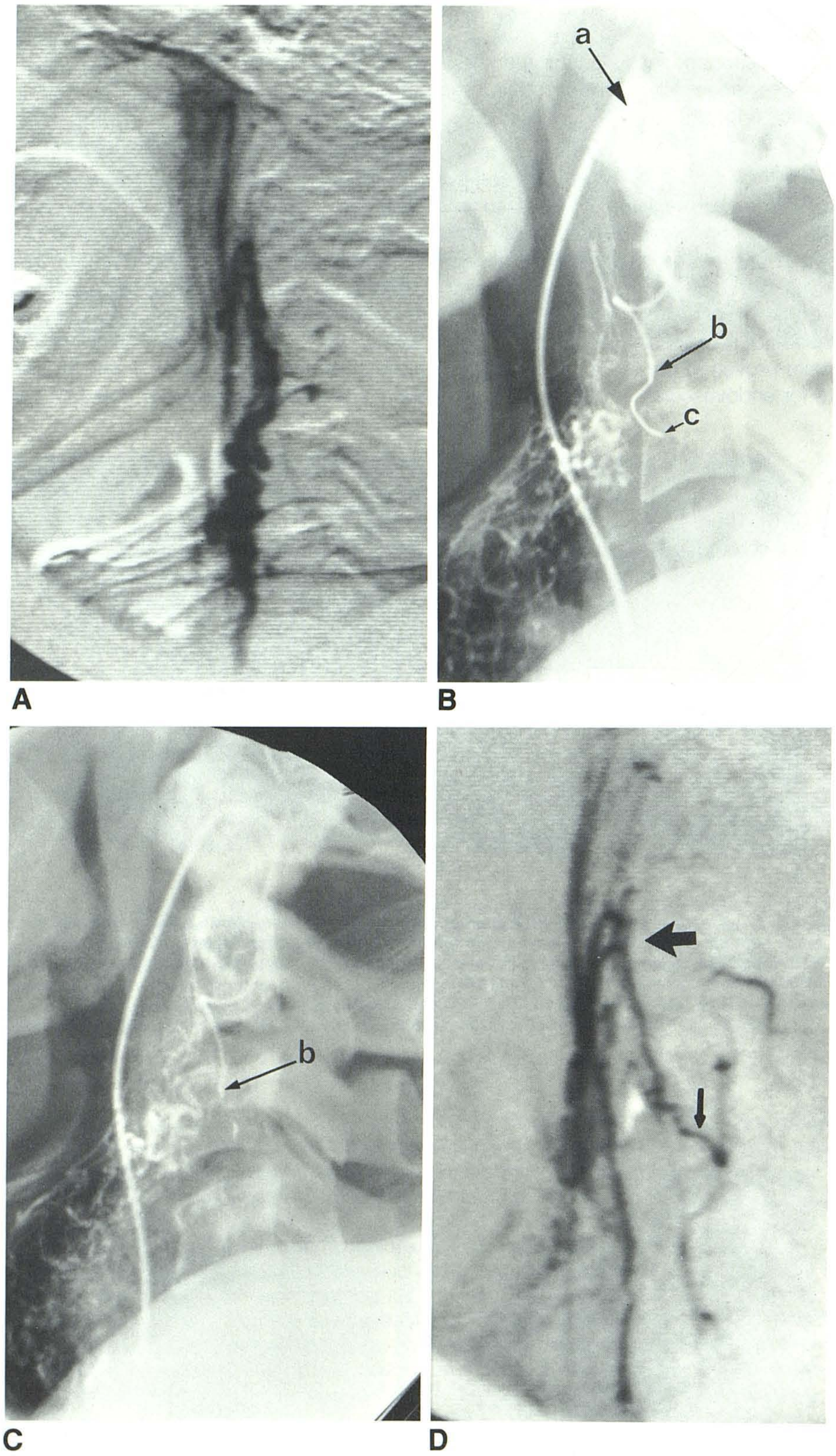


Fig. 7.—*A*, Same patient as in Fig. 6; ascending pharyngeal study. Lateral DSA shows hypertrophy of musculospinal artery. Supply to tumor is from this artery beyond anastomosis with ascending cervical artery.

B, 100 mm spot radiograph shows position of superselective catheter (a), open-ended guidewire (b), and steerable microwire (c).

C, Final position of open-ended guidewire (b) beyond anastomosis with ascending cervical artery as well as acrylic cast from previous embolizations.

D, Lateral DSA postembolization of ascending pharyngeal artery shows preservation of musculospinal artery (*large arrow*) and ascending cervical anastomosis (*small arrow*) and obliteration of tumor angioarchitecture.

sitioned beyond the anastomosis with the vertebrobasilar system (Fig. 3A), the distal cutaneous branches could not be cleared without the open-ended guidewire.

In the next example (Fig. 4), a dural arteriovenous malformation derives its supply from the middle meningeal artery. Superselective catheterization to the level of the foramen spinosum was accomplished with our conventional superselective catheter. The open-ended guidewire was then passed intacranially well beyond possible vessels supplying cranial nerve VII and the inferolateral trunk.

Figure 5 shows an external carotid artery angiogram in which the anterior deep temporal artery that anastomoses with the orbit is feeding a scalp arteriovenous malformation (Fig. 5A). The open-ended guidewire was placed far distally to avoid potential ophthalmic artery embolization (Fig. 5B).

Superselective catheterization is also needed in the ascending cervical and ascending pharyngeal territories. A selective angiogram of the ascending cervical artery (Fig. 6A) fills not only the tumor but the vertebral artery as well. However, our delivery system could be placed directly into the tumor, sparing the ascending cervical to vertebral anastomosis. A control postembolization angiogram shows a marked decrease in the tumor blush, with preservation of the ascending cervical to vertebral anastomosis (Fig. 6B).

In the same patient, a lateral view of an ascending pharyngeal artery angiogram (Fig. 7A) shows supply to the tumor via the musculospinal branch. Our conventional superselective catheter could only be placed at the origin of the musculospinal artery. Embolization from this position, however, would have jeopardized the C4 anastomosis [7, 8]. Therefore, an open-ended guidewire/microguidewire was inserted (Figs. 7B and 7C), which permitted safe IBCA embolization with preservation of the musculospinal artery, the C4 anastomosis, and no filling of the tumor (Fig. 7D).

In summary, use of a coaxial assembly composed of a conventional or superselective catheter, an open-ended guidewire, and steerable microguidewire has greatly facilitated the performance of our surgical neuroangiographic procedures. Simply stated, most of these patients would not have undergone embolization, especially those in whom IBCA was used, had the open-ended guidewire not afforded a safe position from which to proceed. Furthermore, this type of delivery system is presently being evaluated for the treatment of malignant lesions as a means to enable the in situ infusion of cytotoxic agents such as 95% ethanol directly into the arterial side.

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REFERENCES

1. Berenstein A, Kricheff II. Catheter and material selection for transarterial embolization: technical considerations. Part I. *Radiology* **1979**; 132(3):619–630
2. Berenstein A, Kricheff II. Catheter and material selection for transarterial embolization: technical considerations. Part II. *Radiology* **1979**; 132(3):631–639
3. Lasjaunias P, Berenstein A. *Surgical neuroangiography*, vol. II. Embolization of craniofacial lesions. New York: Springer-Verlag, **1986**
4. Djindjian R, Cophignon J, Theron J, et al. Embolization by superselective arteriography from the femoral route in neuroradiology. Review of 60 cases. 1. Technique, indications, complications. *Neuroradiology* **1973**; 6:20–26
5. Meyerovitz MF, Levin DC, Boxt LM. Superselective catheterization of small-caliber arteries with a new high-visibility steerable guidewire. *AJR* **1985**; 144:785–786
6. Sos TA, Cohn DJ, Srur M, Wengrover SI, Saddekni S. A new open-ended guidewire/catheter. *Radiology* **1985**; 154:817–818
7. Lasjaunias P, Berenstein A. *Craniofacial and upper cervical arteries: collateral circulation and angiographic protocols.* Baltimore: Williams & Wilkins, **1983**
8. Lasjaunias P, Berenstein A. *Surgical neuroangiography*, vol. I. Functional anatomy of the craniofacial area. New York: Springer-Verlag, **1986**