AJNR

# An endovascular retrieving device for use in small vessels.

V B Graves, A H Rappe, T P Smith, I Sepetka, A Ahuja and C M Strother

*AJNR Am J Neuroradiol* 1993, 14 (4) 804-808
http://www.ajnr.org/content/14/4/804

# An Endovascular Retrieving Device for Use in Small Vessels

V. B. Graves,[1] A. H. Rappe,[1] T. P. Smith,[2] I. Sepetka,[3] A. Ahuja,[4] and C. M. Strother[1]

**Summary: A new retrieval device for use in small vessels was evaluated in a canine model. Retrieval was attempted on 25 coils, three silicone balloons, and five catheter and guide wire fragments placed in the renal, pulmonary, hepatic, brachiocephalic, subclavian, carotid, and maxillary arteries. This was successful in 91% (30/33). The snare could also be selectively placed in the vertebral and proximal basilar arteries.**

**Index terms: Interventional instrumentation; Foreign bodies; Animal studies**

The increase in use of endovascular devices in the treatment of abnormalities of the central nervous system (CNS) has created a need for a retrieval device suitable for use in small vessels. A variety of retrieval devices, including snares, forceps, and baskets, have been used for retrieval of foreign objects from the peripherial vascular system (1–8). In general, these have not been suitable for use in CNS because of their relatively large size and stiffness. An ideal retrieval device for use in the CNS would have many of the characteristics of the catheters currently in use in interventional neuroradiology. These include: 1) small size (<3 French), 2) softness, 3) steerability, 4) torquability, and 5) tractability. Considering these parameters, one of us (A. H. R.) developed the idea of a single-wire, variable loop snare based on the Tracker 10 and Tracker 18 catheters (Target Therapeutics, Inc., San Jose, CA). The purpose of this study was to evaluate the usefulness of this snare in a canine model. The renal, pulmonary, hepatic, brachiocephalic, subclavian, carotid, maxillary, vertebral, and basilar arteries were all selectively catheterized and coils, balloons, and catheter and guide wire fragments placed in these arteries were retrieved. The clinical application of this retrieval device is presented in the companion report of Smith et al (9).

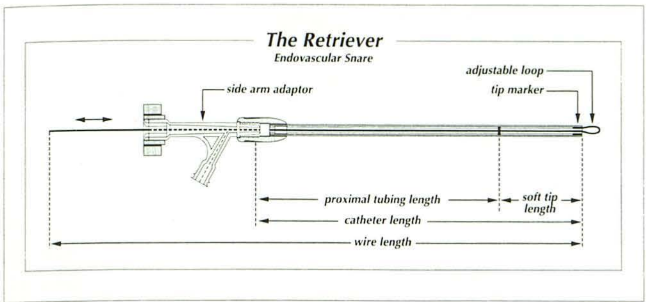
## Materials and Methods

Tracker 10 and Tracker 18 catheters were modified to incorporate a single wire loop at the distal tip. A single stainless steel wire 175 cm in length and 0.010 inches diameter with the distal tip tapered and attached to a 5-cm platinum wire 0.008 inches diameter is attached to the distal tip of the catheter. Platinum is used to make the snare loop visible at fluoroscopy. The distal platinum end of the wire is anchored to the tip of the catheter while the proximal stainless steel end of the wire is free and extends from the catheter hub. By advancing or retracting the free end of the wire at the catheter hub, a loop of wire can be opened and closed at the distal catheter tip. The snare loop has a variable radius that is controlled by the single wire (Fig. 1).

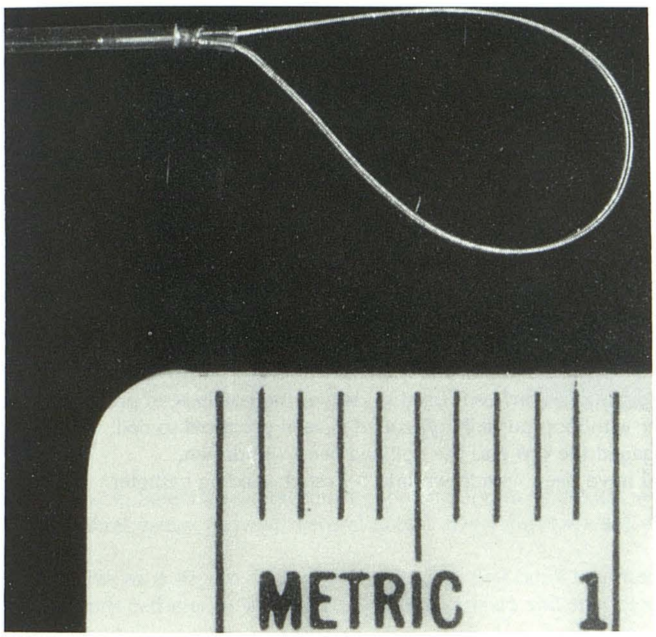
An attempt was made to retrieve 25 coils (5 mm to 5 cm in length, with and without fibers) (Target Therapeutics), three silicone detachable balloons, 4 to 7 mm in diameter and 8 to 13 mm in length (DSB 1.5 L, Interventional Therapeutics, South San Francisco, CA), and five guide wire and catheter fragments from the distal branches of the renal, pulmonary, hepatic, brachiocephalic, subclavian, carotid, and maxillary arteries of dogs. All dogs were studied using sterile techniques and under general anesthesia. No mortality was recorded. The snare was used coaxially with a 5 or 6 French guiding catheter from the femoral route. Coils and catheter and guide wire fragments were placed as far distal as possible using either a Tracker 10 or Tracker 18 catheter as the delivery catheter for coils and the 5 or 6 French guiding catheter to deliver the catheter and guide wire fragments. Balloons were partially inflated, detached, and allowed to migrate distally in the selected artery. For retrieval, the snare was inserted into the guiding catheter and advanced until it was adjacent to the foreign body. The loop was then opened and advanced

Received June 11, 1992; revision requested September 14; revision received October 6 and accepted November 10.
This project was supported in part by Target Therapeutics, Inc. San Jose, CA.
[1] Department of Radiology, University of Wisconsin Clinical Science Center, 600 Highland Avenue, Madison, WI 53792-0001. Address reprint requests to V. B. Graves, M.D.
[2] Department of Radiology, University of California San Francisco, San Francisco, CA 94143-0628.
[3] Target Therapeutics, Inc., San Jose, CA 95134-1806.
[4] Department of Neurosurgery, State University of New York, Buffalo, NY 14051.

AJNR 14:804–808, Jul/Aug 1993 0195-6108/93/1404–0804 © American Society of Neuroradiology




A




B

Fig. 1. *A* and *B*, Retriever 10 endovascular snare, catheter 2.5 F, 150 cm, wire snare 0.010 inches outside diameter, 175 cm.

around the object; this step was followed by closing the loop and trapping the object in the snare.

To test the ability to enter specific intracranial arteries, the snare was used to enter selectively the vertebral and basilar artery in the dog.

## Results

Twenty-three of 25 coils were retrieved (Fig. 2). The two failures were the result of an inability to position the snare in close proximity to the coil. Two of three balloons were retrieved. The single failure occurred when the snare could not be advanced distal to the balloon. Five of five fragments (three catheter and two guide wire) were retrieved. The average time to retrieve any of the devices or fragments was 2 minutes following positioning of the snare adjacent to the foreign body. The snare performed with nearly the same characteristics as a standard Tracker 10 catheter and could be advanced and steered into selected vessels. To facilitate advancement of the snare through a vessel, the snare loop is slowly opened and then closed as gentle pressure is placed on the catheter shaft. This push-pull maneuver results in advancement of the snare and is similar to the technique commonly used for advancement of a standard Tracker catheter over a guide wire (Fig. 3).

Inflated balloons could not be pulled through the guiding catheter or sheath. They were pulled back to the guiding catheter, then the guiding catheter, snare, and balloon were pulled into the femoral artery to the tip of the introducer sheath. The femoral artery was surgically exposed and the contrast-filled balloon was aspirated with a needle through the arterial wall. After deflation the balloon was withdrawn through the sheath.

Two snare failures (2/35) occurred when the snare loop could not be opened or closed. In these two cases, the snare was replaced by a new snare and the object was then retrieved. No devices were lost after they had been captured by the snare. No snare broke even when force great enough to deform the catheter was applied.

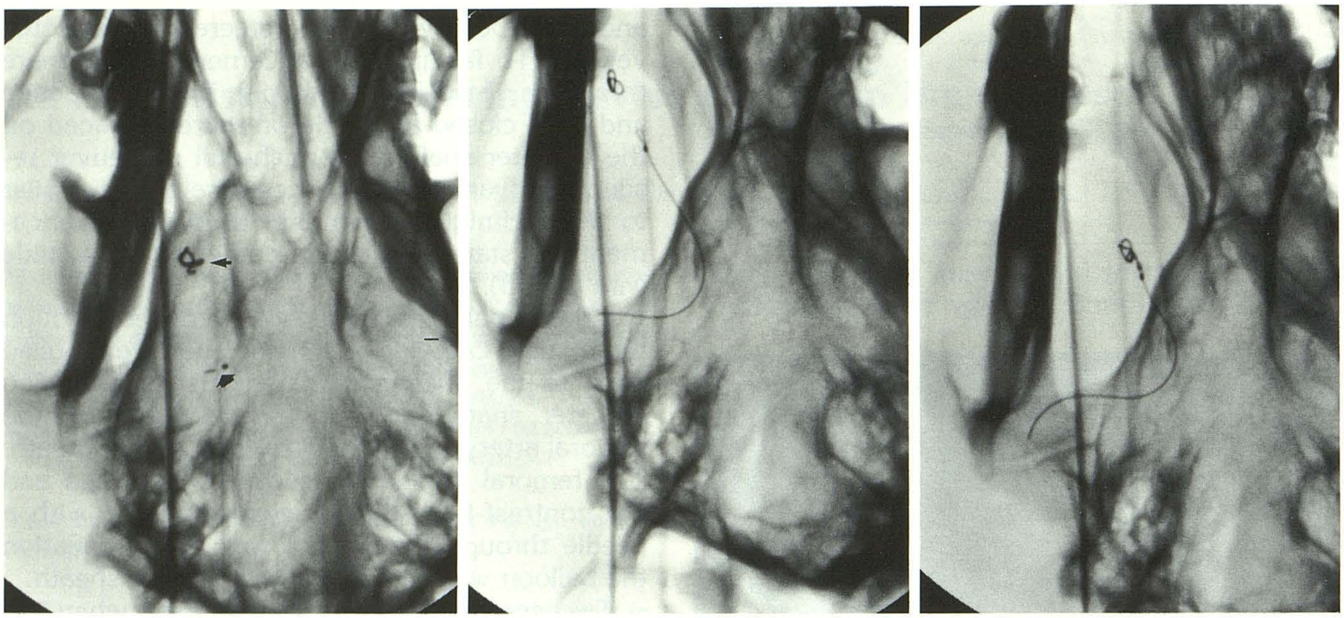
The snare was able to be directed and advanced into preselected regions of the vertebral and basilar vascular system without significant difficulty (Fig. 4). No evaluation was done for endothelial or subintimal damage other than postretrieval angiograms to evaluate for spasm. No vascular spasm was encountered in the vessels that were cannulated.

## Discussion

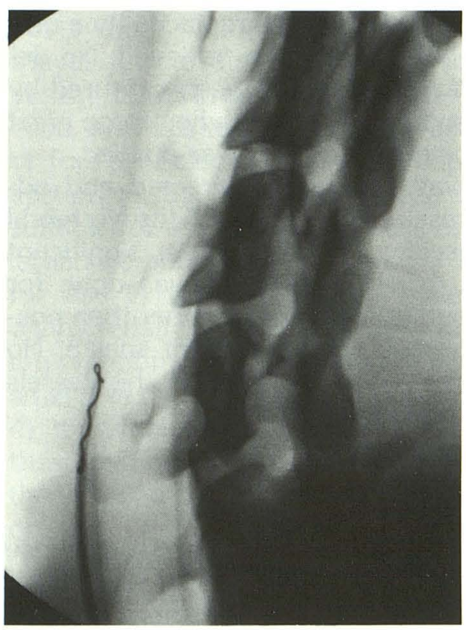
The snare has characteristics similar to those of a Tracker 10 or 18 catheter. The single wire passing through the lumen of the snare catheter does not significantly alter its softness as compared with a Tracker catheter containing a conventional guide wire. The snare loop can be easily retracted so that it barely protrudes from the tip of the catheter, but it is not larger than the tip of the catheter. The steerability and torqueability of the snare is similar to a Tracker catheter.

Certain techniques are important to optimize the usefulness of the snare and they are listed below.

1. Constant perfusion with heparinized saline significantly reduces friction between the wire and catheter lumen. It may also reduce the potential for any clot build-up at the catheter tip or at the base of the snare loop.



A B C



D

Fig. 2. *A*, Submentovertex view showing a 2 cm × 2 mm platinum coil (*arrow*) with Dacron fibers in a distal branch of the maxillary artery. Tracker 10 catheter and platinum tip of coil pusher (*arrowhead*) used to deliver the coil is seen proximal.

*B*, Snare catheter with loop partially extended is seen proximal to coil.

*C*, Snare has engaged the coil and the coil has been withdrawn.

*D*, Snare and coil have been withdrawn into 5 French guiding catheter.

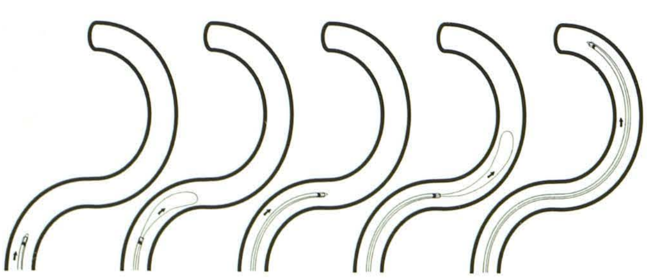
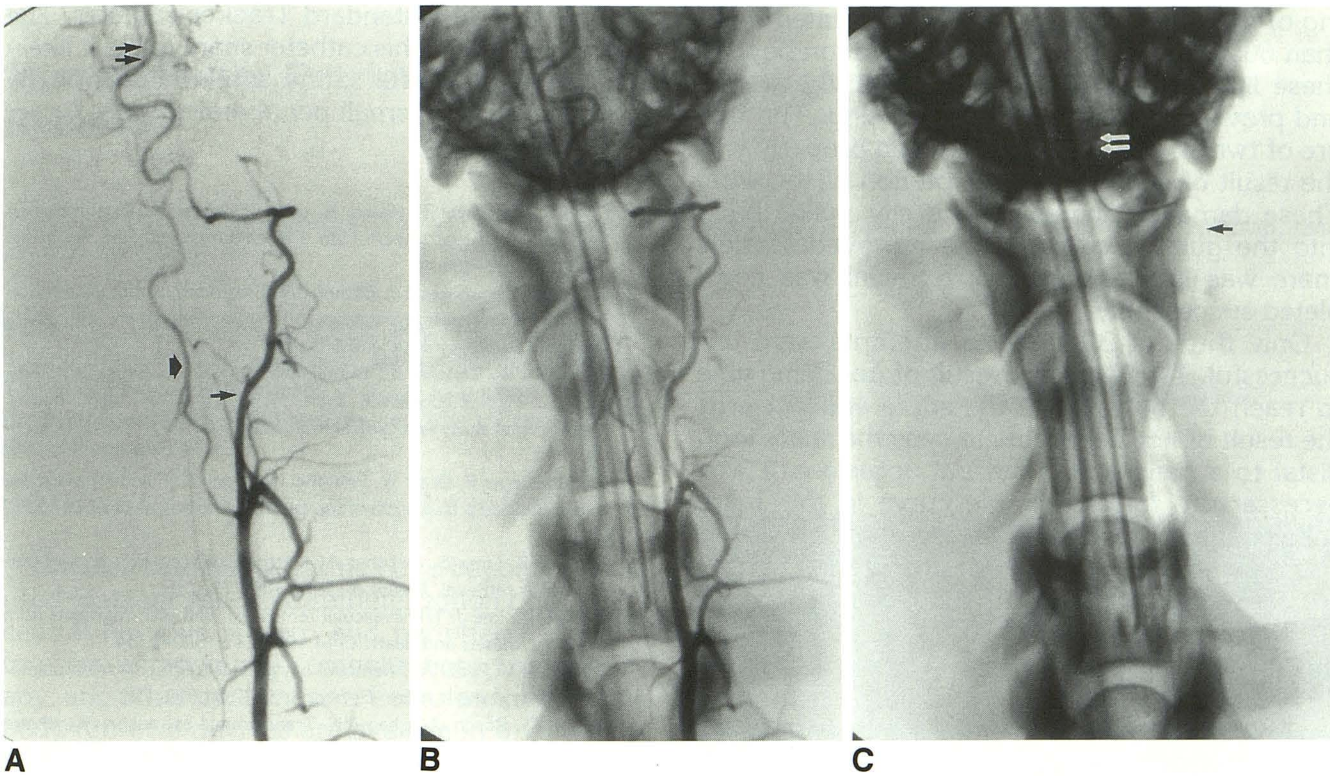


Fig. 3. The loop is opened and advanced distal to the catheter tip. The catheter is then gently advanced over the extended wire as the wire is withdrawn and the snare closed. This maneuver is repeated until the snare is adjacent to the foreign body to be retrieved.

2. The guiding catheter should be positioned as close as possible to the object that is to be retrieved. The snare catheter is not as easy to advance through a vessel as a standard Tracker catheter. Because of this, reducing both the distance the snare must negotiate to reach the object and reducing the distance a retrieved object must be moved is likely to improve the performance of the snare and also increase the safety of the procedure.

3. Advancement of the snare catheter in a vessel is achieved by opening and closing its loop, much in the same manner as a standard guide wire is used in a push-pull fashion to ad-



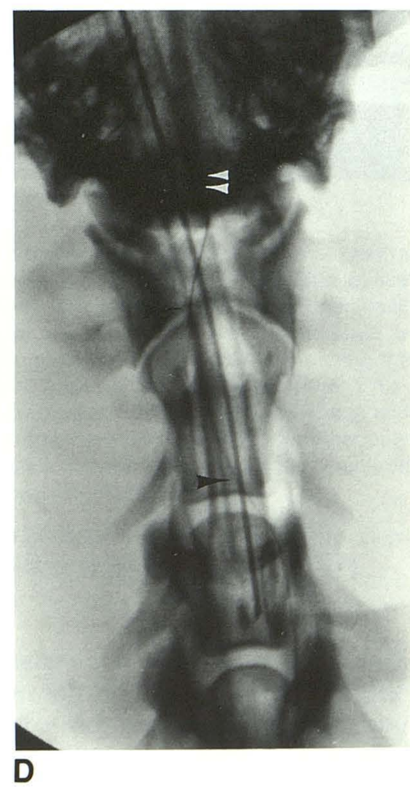




Fig. 4. *A*, Selective digital subtraction angiogram of the left vertebral artery showing the left vertebral artery (*arrow*), ventral spinal artery (*arrowhead*), and basilar artery (*double arrow*).

*B*, Same as is Figure 4*A*, nonsubtracted so that bony landmarks can be visualized.

*C*, Snare catheter in left vertebral artery (*arrow*) and snare loop at ventrobasal junction (*double arrow*).

*D*, Snare catheter in left branch of ventral spinal artery (*arrowhead*) and snare loop in proximal basiler artery (*double arrowhead*).

vance a Tracker catheter. This is the primary method by which this catheter can be advanced through a vessel. The distal platinum loop is extremely soft and is able to assume different configurations. At arterial branching points, the catheter tip is directed toward the desired branch and the loop advanced into the branch. Its softness allows the loop to conform to the shape of the vessel. A fully extended loop often behaves like the distal portion of a guide wire.

4. To avoid twisting the loop, the proximal free end of the wire controlling the opening and clos-

ing of the snare loop should not be rotated more than 60° in either direction. Manipulation beyond these limits may result in its becoming twisted and prevent further opening or closing. The failure of two snares (2/35) to function properly was the result of such excessive rotation of the wire. These damaged snares were easily pulled back into the guiding catheter and removed. A new snare was inserted and the retrieval was completed successfully.

Only three of 33 retrieval attempts were unsuccessful. Two were the result of not being able to reach the object with the snare and one was the result of not being able to pass the snare loop distal to a balloon. On several occasions it was necessary to form a simple curve in the snare catheter tip to facilitate its placement. The catheter was easily shaped with steam and this did not cause any change in its functionality.

## Conclusion

This snare catheter has characteristics similar to those of other small, soft, steerable, and torquable catheters currently used in interventional neuroradiology. It can be advanced within a vessel without significant difficulty in much the same manner as can a standard Tracker catheter. The characteristics of this catheter snare make it likely that it will be useful in the small vessels of the CNS as well as in small peripheral vessels.

## References

1. Furui S, Yamauchi T, Makita K, et al. Intravascular foreign bodies: loop-snare retrieval system with a three-lumen catheter. *Radiology* 1992;182:283–284
2. Selby JB, Tegtmeyer CJ, Bittner GM. Experience with new retrieval forceps for foreign body removal in the vascular, urinary, and billary systems. *Radiology* 1990;176:535–538
3. Yedlicka JW, Carlson JE, Hunter DW, Castaneda-Zuniga WR, Amplatz K. Mitinol gooseneck snare for removal of foreign bodies: experimental study and clinical evaluation. *Radiology* 1991;178:691–693
4. Grabenwoeger F, Dock W, Pinteritis F, Appel W. Fixed intravascular foreign bodies: a new method for removal. *Radiology* 1988;167:555–556
5. Uflacker R, Lima S, Melichar AC. Intravascular foreign bodies: percutaneous retrieval. *Radiology* 1986;160:731–735
6. Aldrige HE, Lee J. Transvascular removal of catheter fragments from the great vessels and heart. *CMA* 1977;117:1300–1304
7. Schechter E, Parisi AF. Removal of catheter fragments from pulmonary artery using a snare. *Br Heart J* 1972;34:699–700
8. Dotter CT, Rösch J, Bilbao MK. Transluminal extraction of catheter and guide fragments from the heart and great vessels: 29 collected cases. *AJR: Am J Roentgenol* 1971;111:467–472
9. Smith TP, Graves VB, Halbach VV, Higashida RT, Fraser KW, Dowd CF, Hieshima GB. Microcather retrieval device for foreign body removal. *AJNR: Am J Neuroradiol* 1993;14:809–811