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# Materials and Techniques for Percutaneous Retrieval of Intravascular Foreign Body

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| **Abstract:** | The presence of an Intravascular Foreign Body (IFB) represents a well-known risk of serious complications. In the past, surgical removal of IFB has ben the only option available. However nowadays percutaneous approach in retrieval an IFB is widely accepted as first line technique.<br>In literature are generally described many case reports performed by various operators, with different experience, techniques and materials.<br>In this paper we illustrated the main materials and techniques applied for percutaneous retrieval of IFB, in order to simplify the different possibilities adaptable to different clinical situations. |
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**REVIEW**

# Materials and Techniques for Percutaneous Retrieval of Intravascular Foreign Bodies

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**Materials and Techniques for Percutaneous Retrieval of Intravascular Foreign Bodies**


## Abstract

The presence of an Intravascular Foreign Body (IFB) represents a well-known risk of serious complications. While in the past surgical removal of IFB was the most common intervention, nowadays a percutaneous approach in the retrieval of an IFB is widely accepted as the first line technique. In the literature, many case reports describe different techniques and materials. This paper summarizes and illustrates the main materials and techniques currently applied for percutaneous retrieval of IFB, providing a simplified tool with different interventional possibilities, adaptable to different clinical situations.


## Introduction

In the last two decades, endovascular procedures and devices have been used for an increasing numbers of clinical problems. Consequently, case series and reports regarding intravascular foreign body (IFB) retrieval have been extensively published. The first case report was published in 1954, when an intravascular catheter was found into the right atrium at autopsy [1]. Ten years later, the first report of a successful percutaneous recover was published: a fragment of a broken guide-wire was found into the right atrium and recovered with a rigid bronchoscope forceps [2]. The most common IFBs are: broken central lines and guide-wires, angiographic catheter fragments, inferior vena cava filters, embolization coils or occluding devices, endovascular stents, cardiac valve fragments [1-9]. The majority of cases deal with vascular access in dialysis and oncology patients [10-13].

Since 1964, a variety of endovascular techniques and devices have been developed and used to approach this clinical situation, such as: loop snares, baskets, balloon catheters, grasping forceps, and tip-deflecting wires [2-7]. Nowadays, endovascular approach is widely accepted as first-line treatment for retrieving IFBs, while surgery is usually proposed as a second option [3-6]. This has

increased the indication even to more fragile patients such as in the paediatric (developing) and in geriatrics (aging) one.

Given the wide range of possible endovascular devices and IFBs, an accurate preoperative planning with Multi-Detector Computed Tomography (MD-CT) imaging is mandatory to choose the best approach [3,14].

The aim of this paper is to describe in a schematic and valuable way the main endovascular materials and techniques for IFBs retrieval, in order to provide the operator with a clear range of options that can be used in this peculiar setting.

## Imaging Study for Intravascular Foreign Body Retrieval

A preoperative multidisciplinary team discussion with a preliminary diagnostic imaging evaluation is mandatory, in order to chose the most appropriate method and technique for each patient with IFB.

Conventional X-Ray is the first-line imaging technique, but it gives only a projective localization of the IFB (not its exact location), moreover it can be used only for radiopaque materials.

Multi-Detector Computed Tomography (MD-CT) is considered the gold-standard imaging technique in this setting, because it gives information about: IFB's characteristics and it's exact anatomical location [3,14]. Ultrasound is generally used only intra-operatively, as it is considered a mandatory tool for endovascular access [15]. Finally, high-resolution Digital Subtraction Angiography (DSA) is essential in order to perform the IFB removal with an accurate vision of all endovascular procedure phases [16].

## Materials for Intravascular Foreign Body Retrieval

### *a) Loop Snare*

In the past decades, snares were homemade, through the use of a small calibre guide-wire that was folded onto it self (thus forming a loop) and inserted into an angiographic catheter. But, in this way

the loop was rigid and gave it a slightly directional shape, as it was on the same plane as the catheter. Nowadays, modern loops have been produced with the following characteristics: a single strait guide-wire loaded into an angiographic catheter, where an a-traumatic soft metal ring is welded at its distal end [3,14].

Furthermore, snare devices can have: a range of sizes (from 2 mm to 35 mm), variable emerged angle (from 0° to 90°), and they can have from one to three loops. All these characteristics greatly facilitate manipulation of the devices aiding the IFB retrieval.

***b) Angioplasty Balloon Catheters***

Conventional angioplasty balloon catheters (coaxial or monorail type) are used as devices for lock and then pull (with the aim to remove) IFBs that have an inner lumen or hole [3,7].

It is important to select an appropriate size of the balloon catheter. Usually, a balloon catheter 1-2 mm oversized respect the inner-lumen or the hole of the IFB is chosen in order to have a good and permanent grip between the inflated balloon catheter and the IFB.

***c) Intravascular Baskets and Filters***

Baskets are well-known devices made by two nitinol wires looped together giving a basket shape. The basket device has various sizes, and the smaller one is less than 3-Fr, to allow the introduction into low profile catheters and access small-caliber vessels. Embolic protection filter devices can be used as basket to remove short and small IFB in smaller, tortuous and distal vessels [6].

***d) Intravascular Grasping Forceps***

Intravascular grasping forceps are devices equipped with two distal tapered metallic jaws. These two metallic jaws can be opened and closed via a manual control at the bottom of the device. This device guarantees excellent grip even in IFBs without a free edge. They are available in a range of sizes from 3-Fr to 12-Fr [3]. It should be underscored that they have to be used by experienced operators as they can cause vessel wall damage or perforation [3,4,14].

**Techniques for Intravascular Foreign Body Retrieval**

***1) Loop Snare Proximal Grab Technique***

The loop snare proximal grab technique is the usual technique used for soft cylindrical with free edge IFBs (Figure 1 A-E). The size of the loop snare has to be equal or slightly smaller than the vessel diameter and bigger than the IFB diameter. When the IFB is bent, it acquires a kinked shape. So it is imperative that the whole system is loaded into an introducer with a lumen at least twice the original diameter of the IFB.

***2) Loop Snare Lateral Grasp Technique***

The loop snare lateral grab technique is the classic technique used for soft cylindrical IFBs without free edge (Figure 2 A-E). The loop snare is opened distal to the IFB, then a guide-wire is passed on the other side of the IFB and through the snare loop. After having stabilized the whole system (snare loop - guide-wire - kinked IFB), retrieval is performed through a long sheath introducer (with its tip as close as possible to the IFB) with an inner lumen twice the original diameter of the IFB.

***3) Loop Snare Grasp - Guide-wire Technique***

The loop snare grasp - guide-wire technique is the usual technique used for not soft cylindrical IFBs, characterized by an inner lumen and a free edge (Figure 3 A-E). The double use of the loop snare and of the guide inside the lumen of the IFB guaranties an excellent stability of the system. Finally, an introducer (through the vascular access) with an inner diameter slightly above the diameter of the IFB is used for the removal.

***4) Angioplasty Balloon Catheter Technique***

The angioplasty balloon catheter technique is used for cylindrical IFBs, with a inner lumen and a free edge (Figure 4 A-E). This technique presents two practical advantages: first, a firm grip between the balloon and the IFB, and second a tapered new tip at the proximal end of the IFB which allows a better input into the introducer during the removal. Two principles have to be considered: the diameter of the balloon catheter must be slightly larger than the internal lumen of the foreign body, and the balloon has to be inflated at low pressure (only to guarantee a grip with the IFB).

***5) Dormia Basket and Filter Technique***

The Dormia basket and filter techniques are two well-known techniques used for short and not essentially cylindrical in shape IFBs (Figure 5 A-E) (Figure 6 A-E). Dormia basket is used for medium-large IFBs located in large-diameter vessels. On the other hand, the Dormia filter is used for small diameter IFBs located in peripheral vessels. When the IFB has been captured, it is necessary to use a traction force that guarantees only the grip and not the possible breaking of the IFB (especially if it has a soft nature).

***6) Aspiration Catheter Technique***

The aspiration catheter technique is an unconventional technique used in selected cases for small and generally cylindrical IFBs (Figure 7 A-E). This technique is based on two concepts: the IFB must be stranded in a vessel reachable by the aspirating catheter (which must have an internal lumen greater than IFB), and the use of a luer-lock syringe or a negative pressure pump to create a vacuum effect, which guarantees the aspiration of the IFB into the catheter inner lumen.

***7) Retrieval Forceps Technique***

The retrieval forceps technique is a not conventional technique used in selected cases for IFBs without a free edge (Figure 8 A-E). This technique is still relatively high risk for causing possible iatrogenic vessel wall damage or perforation. So, an accurate preliminary imaging evaluation of IFB (size, shape, anatomic dislocation), and the use of high-definition fluoroscopy with multiplanar images are necessary conditions for the retrieval forceps technique.

## Discussion

The increasing number of endovascular procedures has also increased the possible number of complications, including the endovascular shedding of IFBs. The majority of cases described are associated with vascular access devices, given their growing frequency of placement in dialysis and oncology patients [3-5, 17].

IFBs represent a feared complication of the endovascular procedures, leading to possible severe adverse events (infections, thrombosis, ischemia, perforation, and cardiac arrhythmias) if not retrieved [1-9]. The rate of these adverse events is reported as high as 71% [5,9]. This suggests that

IFBs removal must be done as soon as possible. Given the wide range of possible IFBs, a multidisciplinary approach to manage such endovascular complication is mandatory, with an accurate clinical and imaging preoperative planning to choose the best approach and procedure [3,16-18].

Nowadays, the endovascular approach is considered the first-line method for retrieving IFBs [3-6]. It offers a high success rate with a low associated morbidity [3-9, 19]. Skills in endovascular procedures and good knowledge of materials are mandatory to approach these challenging clinical situations [3-7]. However, the endovascular approach may not be always appropriate or possible in retrieving IFBs in up to 6% of the cases. So, open surgery retrieval is still indicated in these few cases [19].

After a multidisciplinary decision of an endovascular approach, the best technique and the optimal materials to use should be considered. The above described endovascular techniques can be applied individually or in combination with each other, since every case of IFB retrieval is different from the other [19-21]. Overall, the complications rate related to endovascular percutaneous retrieval procedures for IFBs is low. The most frequently reported include: cardiac arrhythmia, vascular and cardiac perforation, artery spasms and thrombosis [3-7, 22].

In conclusion, in most cases IFBs represent a challenging clinical situation. Therefore the good knowledge of materials and techniques for IFB percutaneous removal allows to perform the procedure with higher technical and clinical success.

**Figures**

***Figure 1 A-E: Loop Snare Proximal Grab Technique***. A) Presence of intravascular foreign body (*) and angiographic catheter (arrowhead). B) A loop snare is loaded into the angiographic catheter lumen (arrowhead) that is advanced above the proximal (or lower) end of the intravascular foreign body. C) The intravascular foreign body is grasped with a pull back technique of the loop snare (arrow). D) Fastening system (arrowhead) is used on the guide-wire of the loop snare to stabilize

the whole system. E) The whole system is then retrieved (arrow) inside the introducer (arrowhead), which must have a suitable inner diameter to allow the entry of the foreign body that now has twice its original diameter as it is retrieved in a kinked fashion.

***Figure 2 A-E: Loop Snare Lateral Grasp Technique***. A) A kinked intravascular foreign body in seen in the vessel (*), so a loop snare is loaded in an angiographic catheter (arrowhead). B) The loop snare is passed over the intravascular foreign body. C) Passing through the same introducer, an angulated angiographic catheter (arrowhead) advances near the intravascular foreign body. Then a strait guide-wire is pushed over the intravascular foreign body on the other side through the loop snare. D) With a pull back technique of the guide-wire of the loop snare, the strait guide-wire is grasped, and the whole system is then stabilized by the fastening system on the guide-wire of the loop snare (arrow). E) The whole system is then retrieved (arrow) inside the introducer (arrowhead), which must have a suitable inner diameter to allow the entry of the foreign body that now has twice its original diameter as it is retrieved in a kinked fashion.

***Figure 3 A-E: Loop Snare Grasp - Guidewire Technique***. A) Presence of intravascular foreign body (*) and angiographic catheter with a loop snare loaded (arrowhead) and advanced above the proximal (or lower) end of the intravascular foreign body. B) With a pull back technique of the loop snare (arrow), the intravascular foreign body is grasped; then an angulated angiographic catheter with a strait guide-wire (arrowhead) is advanced near the proximal (or lower) end of the intravascular foreign body. C) After using a fastening system (arrow) on the guide-wire of the loop snare to stabilize the whole system, the guide-wire of the angulated angiographic catheter is advanced into the intravascular foreign lumen (arrowhead). D) The angulated angiographic catheter is removed. E) The whole system is then retrieved (arrow) inside the introducer (arrowhead), which may have an inner diameter slightly above the diameter of the foreign body.

***Figure 4 A-E: Angioplasty Balloon Catheter Technique***. A) Presence of intravascular foreign body (*) and an angulated angiographic catheter (arrowhead) that has a straight guide-wire inside. B) The guide-wire of the angulated angiographic catheter is advanced into the intravascular foreign lumen (arrowhead). C) Leaving the guide-wire in place, the angulated angiographic catheter is removed and a balloon catheter (arrowhead) is loaded over the guide-wire (the balloon catheter must have a diameter slightly above the internal lumen of the foreign body). D) The balloon catheter is advanced into the foreign body lumen and then it is inflated at low pressure. E) The whole system is then retrieved (arrow) inside the introducer (arrowhead), which may have an inner diameter slightly above the diameter of the foreign body.

***Figure 5 A-E: Dormia Basket Technique***. A) Presence of intravascular foreign body (arrow) and an angiographic catheter (arrowhead). B) A Dormia basket (arrowhead) is loaded into the angiographic catheter. C) The Dormia basket is advanced open (arrow) over the intravascular foreign body. D) With a pull back technique of the Dormia basket (arrow) the intravascular foreign body is grasped. E) After using a fastening system (arrow) on the guide-wire of the Dormia basket to stabilize it, the whole system is then retrieved (long arrow) inside the introducer (arrowhead), which may have an inner diameter slightly above the diameter of the foreign body.

***Figure 6 A-E: Filter Technique***. A) Presence of intravascular foreign body (arrow) and an angiographic catheter (arrowhead). B) An angiographic filter (arrowhead) is loaded into the angiographic catheter, which is passed over the foreign body. C) The angiographic filter is retracted (arrow), in order to capture the body. D) Fastening system (arrow) is used on the guide-wire of the filter to stabilize the whole complex. E) The whole complex is then retrieved (arrow) inside the introducer (arrowhead), which may have an inner diameter slightly above the diameter of the foreign body.

***Figure 7 A-E: Aspiration Catheter Technique***. A) Presence of foreign body (arrow) within a vessel (*), and angiographic catheter (arrowhead). B) The angiographic catheter is advanced (arrow) with its tip just at the proximal (or lower) end of the intravascular foreign body (the inner

diameter of the angiographic catheter must be bigger than the diameter of the intravascular foreign body). C) The distal part of the angiographic catheter is connected to a syringe or aspiration system. D) Exerting negative pressure with the syringe or activating the aspiration system, the intravascular foreign body is aspirated within the angiographic catheter (arrowhead) and then removed.

***Figure 8 A-E: Retrieval Forceps Technique***. A) Presence of intravascular foreign body (arrow) and intravascular retrieval forceps (arrowhead). B) The intravascular retrieval forceps are advanced close to the intravascular foreign body and then opened (arrow). C) With gentle movements the intravascular foreign body is then grasped, through the closure of the intravascular retrieval forceps (arrow). D) The whole system is then retrieved (arrow) inside the introducer (arrowhead), which may have an inner diameter slightly above the diameter of the foreign body / intravascular retrieval forceps.

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Figure 1

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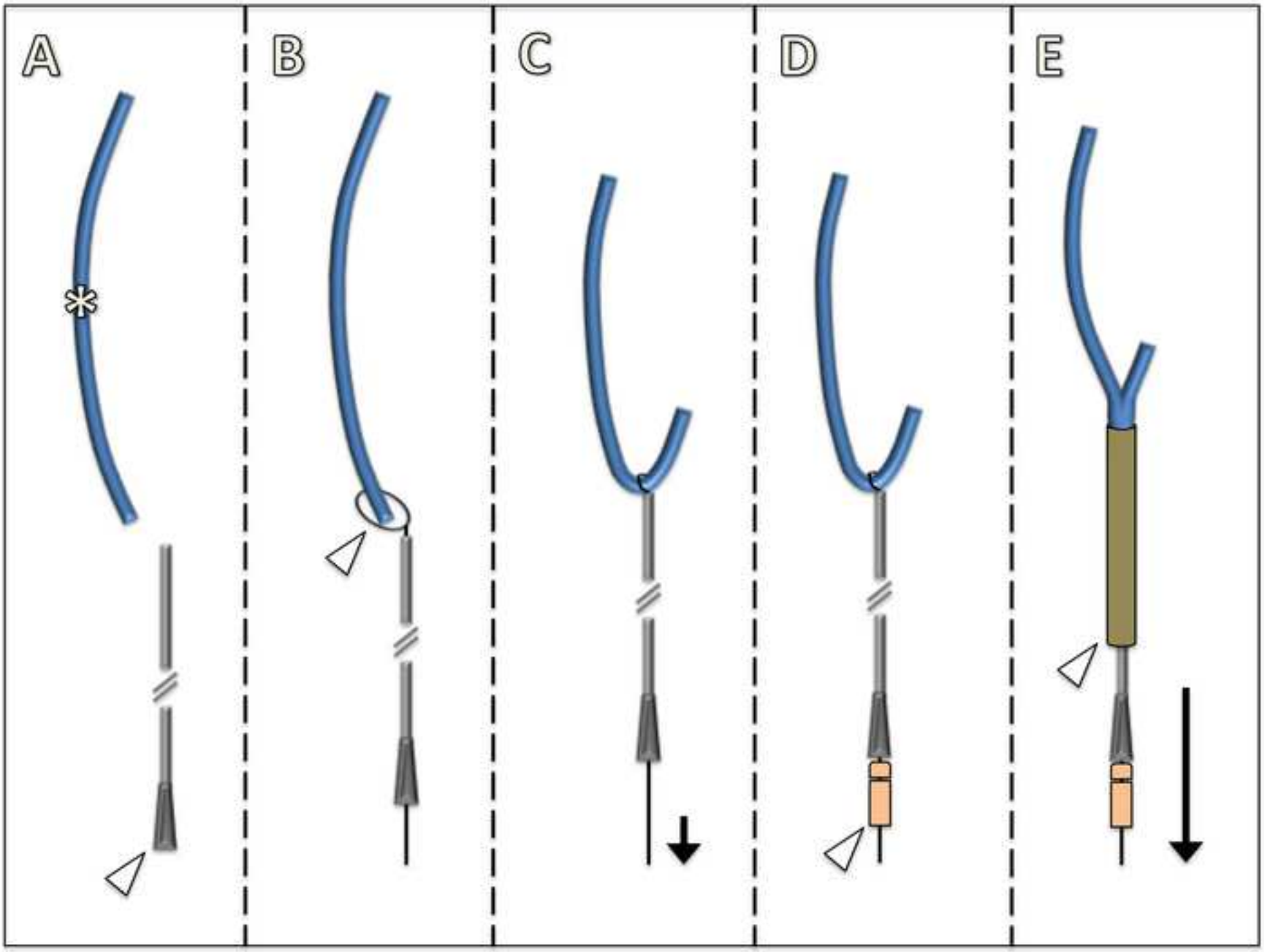

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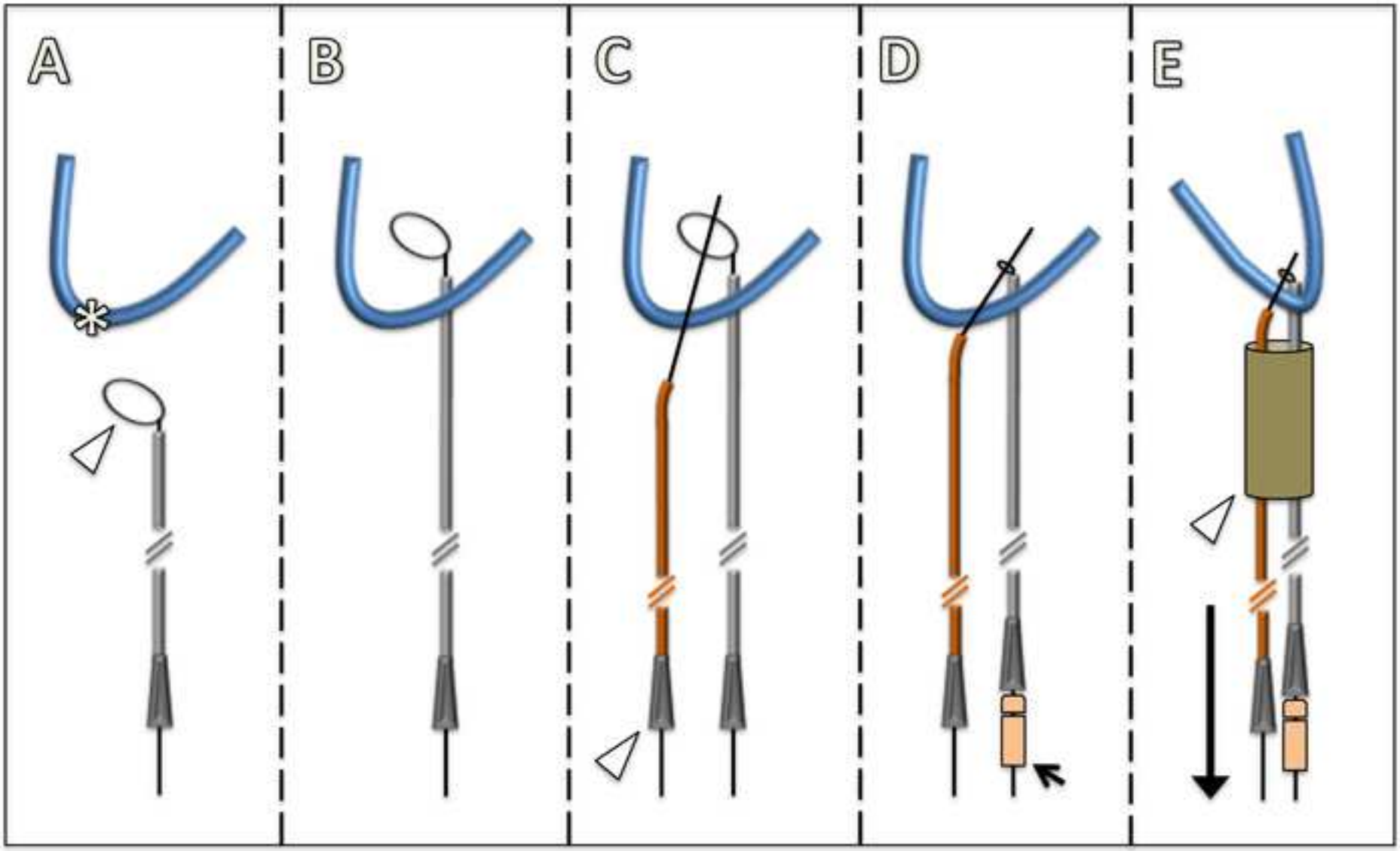

Figure 3

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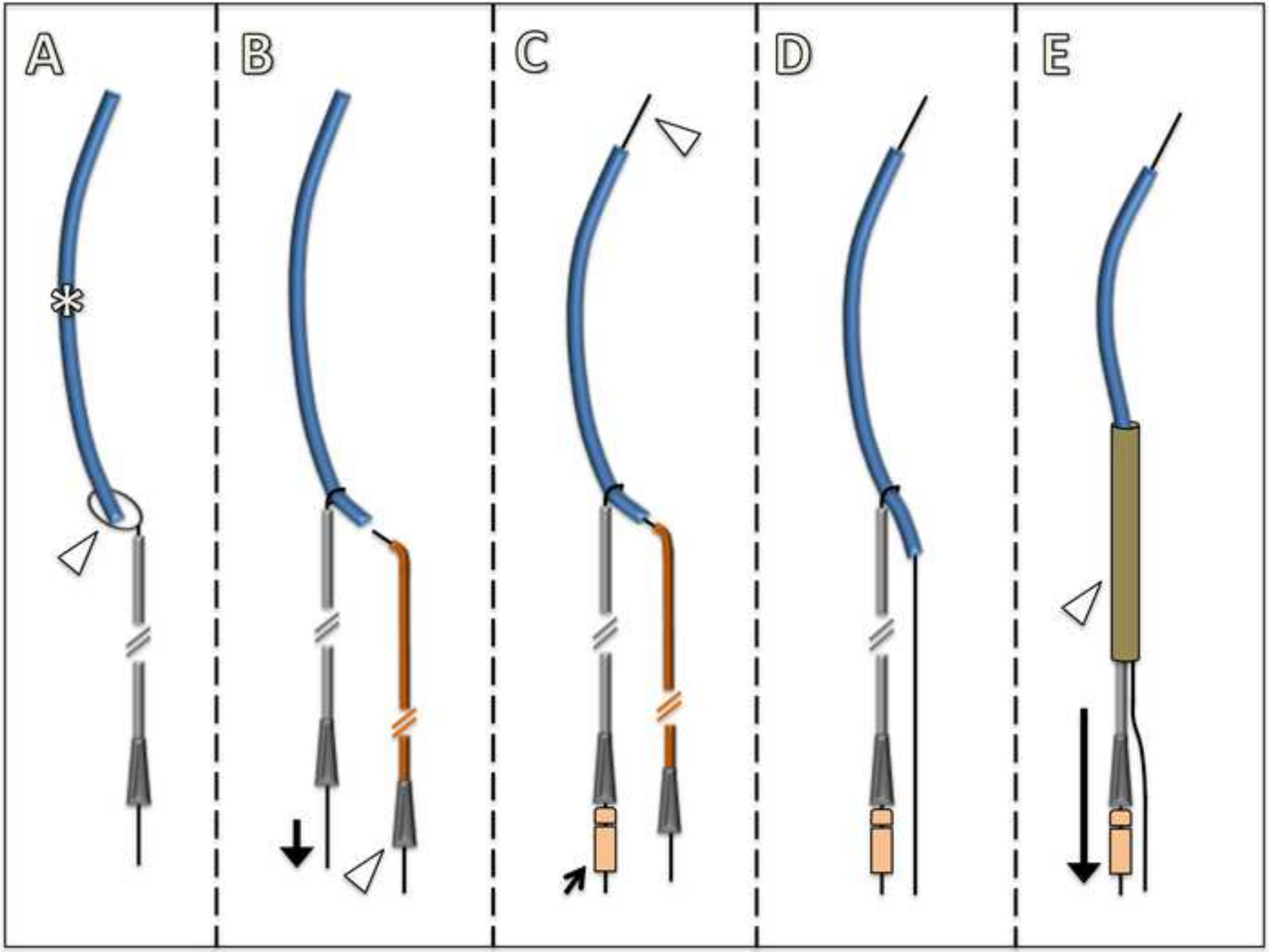

Figure 4

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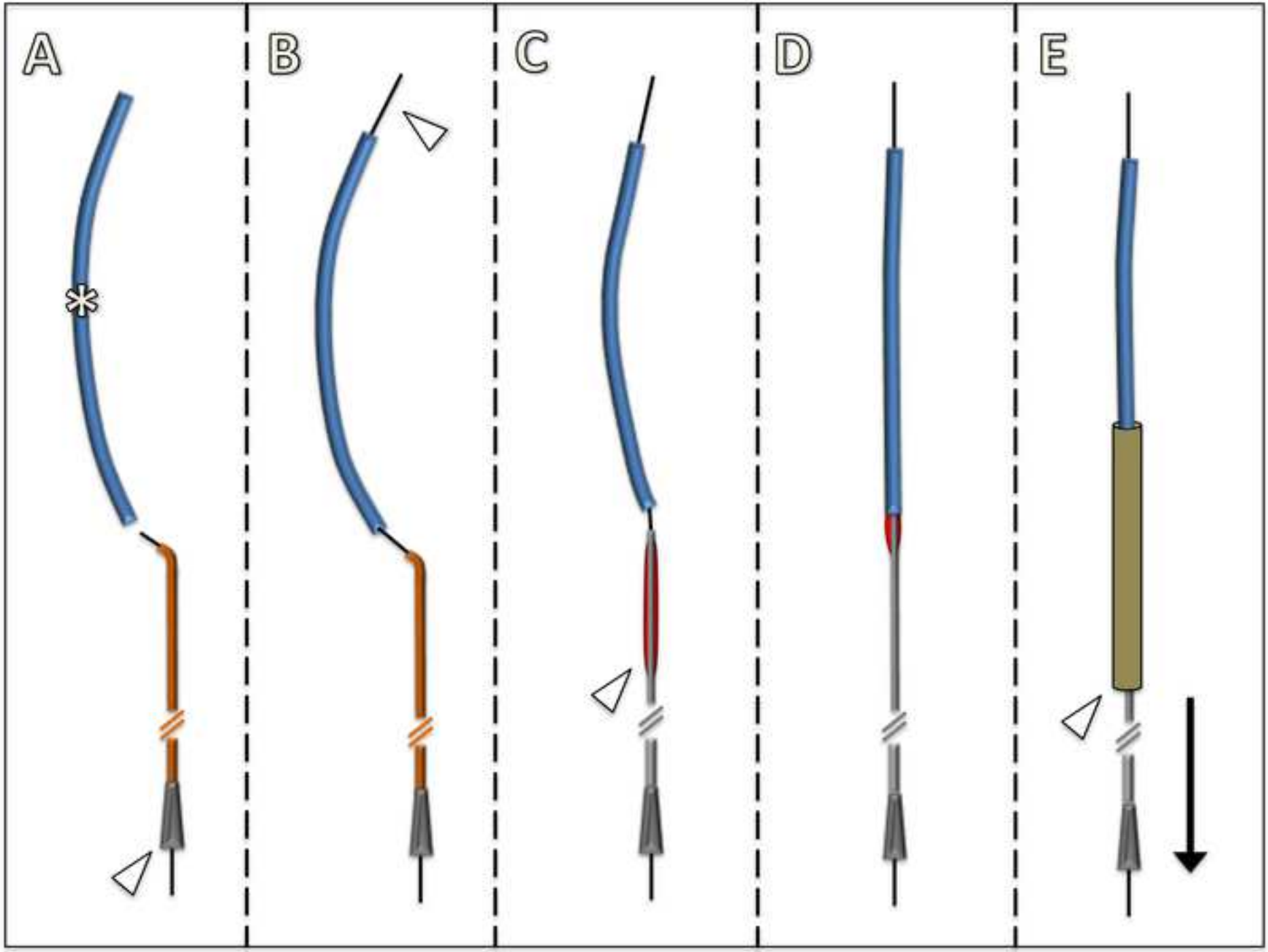

Figure 5

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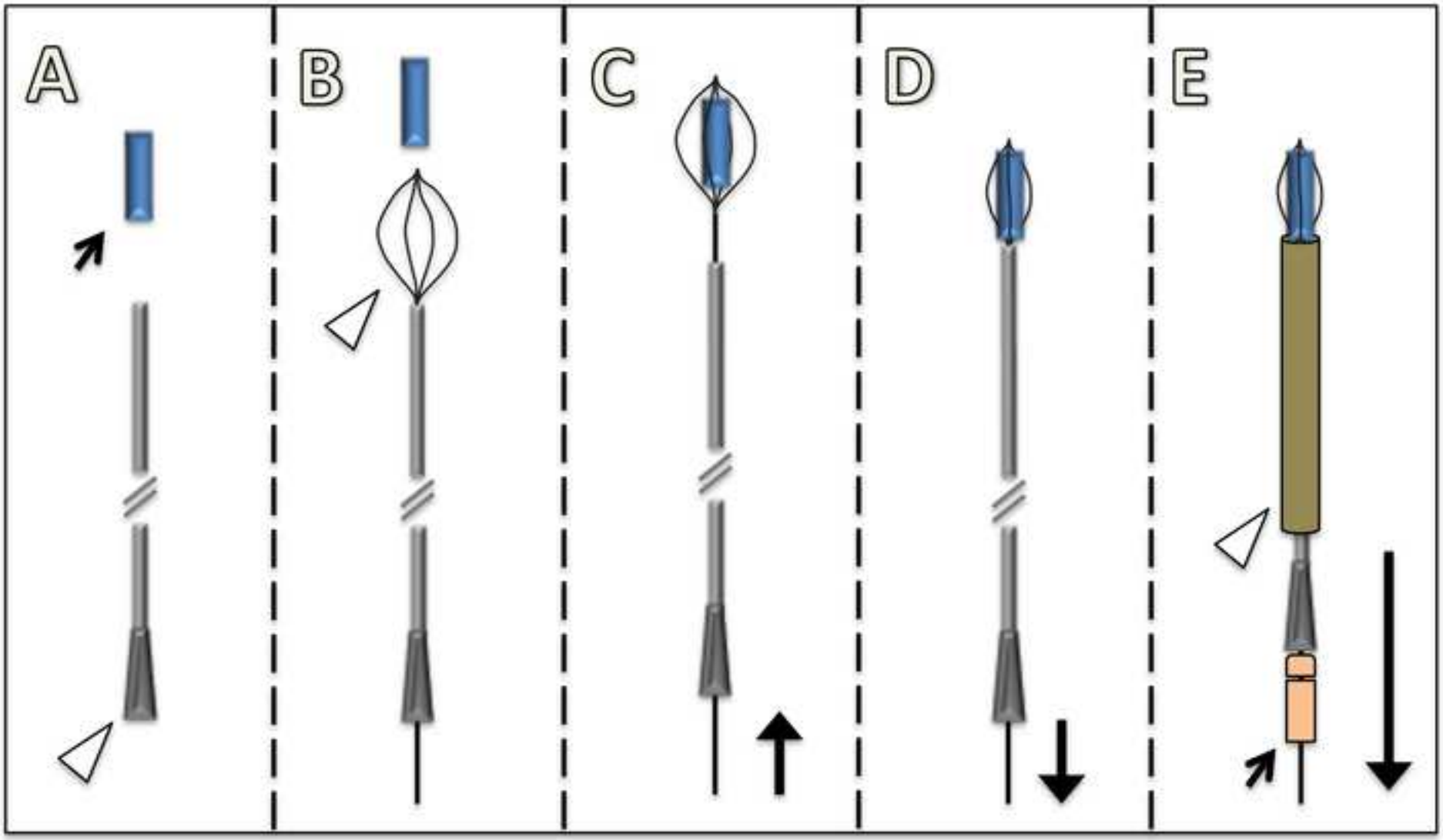

Figure 6

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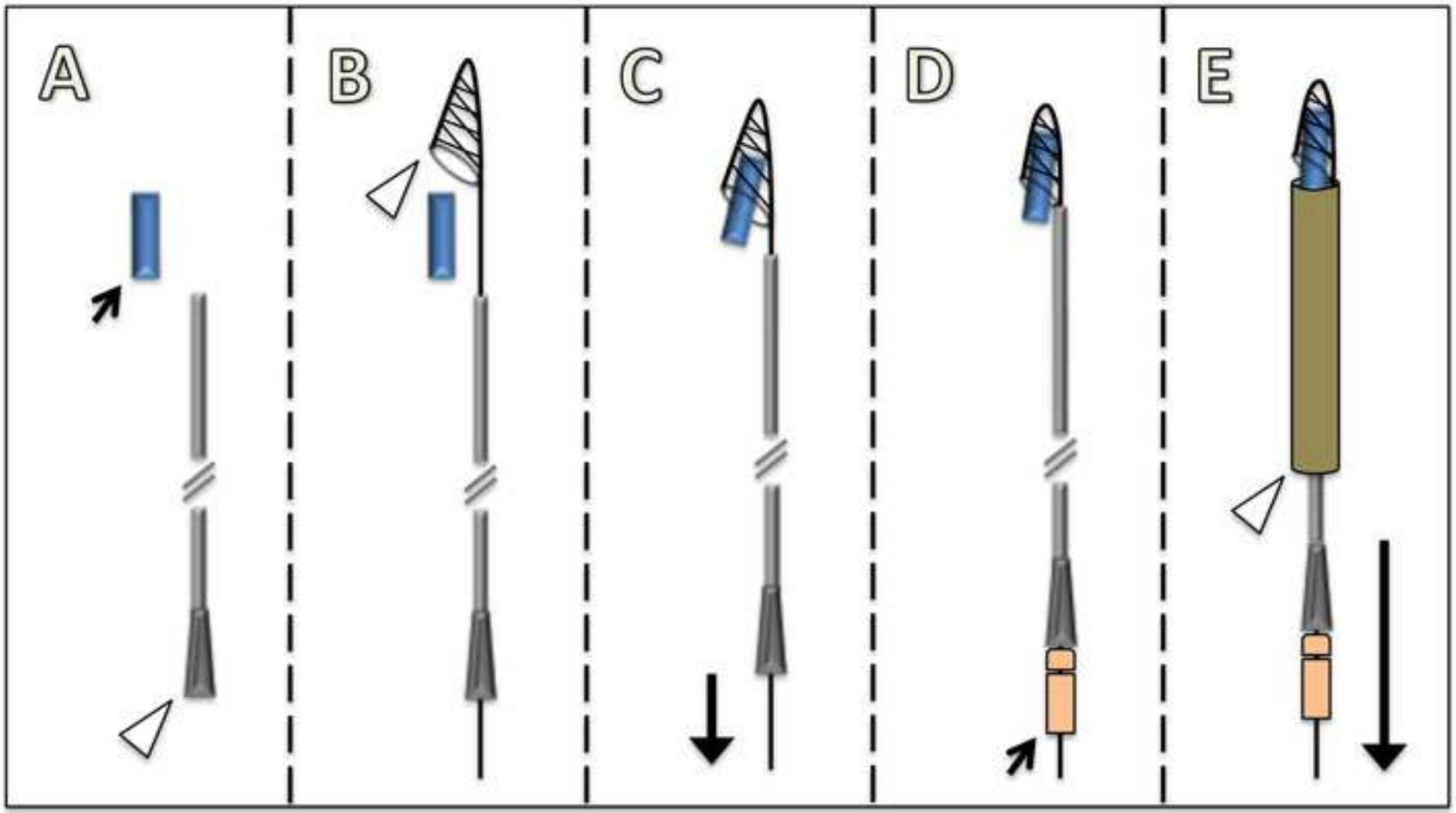

Figure 7

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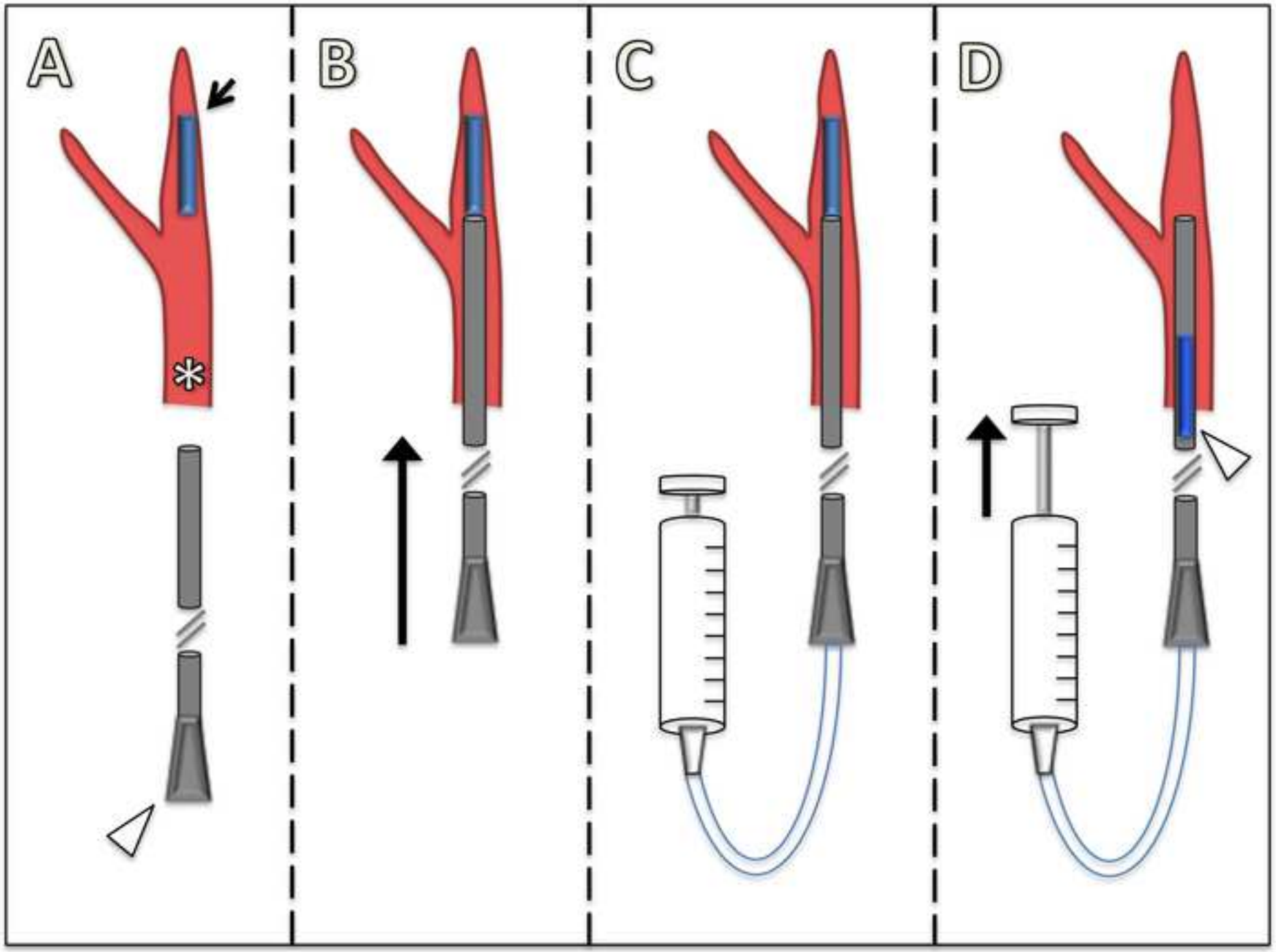

Figure 8

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